CHEMICAL & METALLURGICAL ENGINEERING

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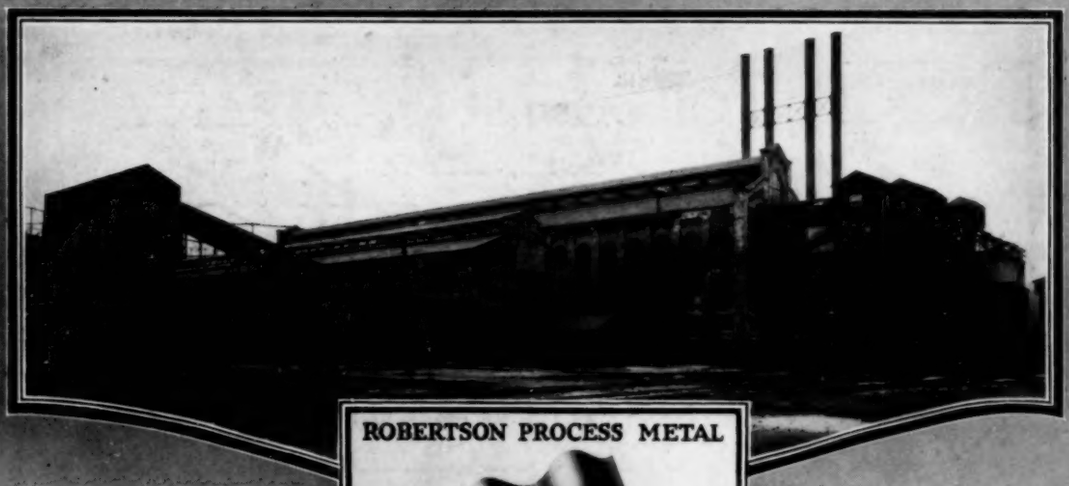

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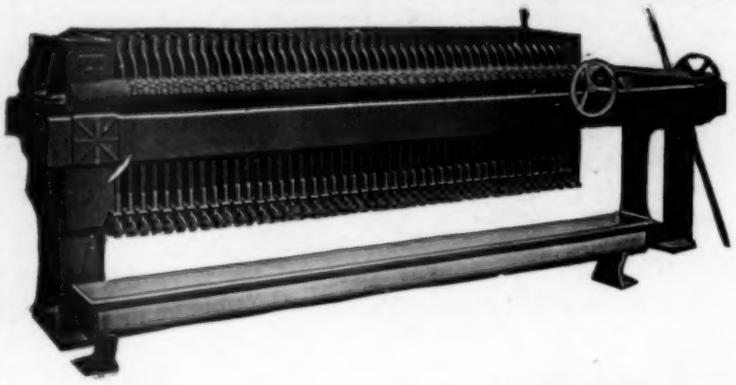

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The Persistent Relativity of Things

THERE is something that everybody knows in a kind of a sleepy, half-awake, dull way; that he carries along rather beside than within his consciousness; as though he had the information stowed away in some compartment of his brain to which the door is closed. This something is the fact that Society does not stop when any of us dies, and that the world does not stop when we come to the custom house, and that even if we mind our own business we are not always sure to tread the path of wisdom.

It was not many years ago when the last thing on earth that any government would give up was the issuance and coinage of its own money. Today everybody is looking for some kind of international currency with which to trade, and we are beginning to realize that if nations would merely live on the same earth with one another and without even attempting to make a show of comity, they must have tokens and conventions over and above their respective boundaries.

We have no international propaganda to offer, and we are wholly out of sympathy with our lately naturalized fellow citizens of the soapboxes who prefer a Soviet government to that of the United States. But we must learn to think across the borders of our own bailiwicks, our own language, our own interests and our own lives.

With increased means of communication and transportation this earth is growing smaller every day, so that our lives and activities, even at great distances apart, overlap each other in increasing measure. Indeed, if we are not mindful of our potentialities of nuisance and of destruction we may be sure others will discover them for us—and they will call a halt if we haven't sense enough to stop of our own accord.

We have suffered a great deal in this country from the stripping of transportation systems and of industries to make profit for temporary stockholders. We are still pretty sleepy and drowsy while this unconscionable chicanery is going on and we seldom wake up until the damage is done. We must, for the sake of safety, get a bigger vision of things than most of us enjoy, and to those of us to whom this is impossible—to the 12-year-olds in mind who are willing to try anything because they cannot co-ordinate cause with effect—the only safety is to get the light from those who can see. We must have trade with Europe, we must conserve our industries, and we must provide for decent lives for all the people who work for us. We must look beyond our own interests and see what harm our good may do. A year ago we were all talking about relativity. Have we forgotten that there is such a thing? Has the sense of relativity departed from the world just as the nature of it was made manifest?

On Writing Technical English

THE other day a very kindly and appreciative letter came in from one of our subscribers who is eminent in chemistry. It commended some writings about a subject that is difficult of exposition, and was just the sort of a letter that encourages an editor to do his best. It contained also a word of gentle criticism. The writer regretted that at times the language fell below the dignity of the subject, as when the author spoke of the periodic table as "the blamed thing," and again when he says that he "once attended Sunday School."

"De gustibus non est disputandum." And yet, the next time we are born in this vale of tears, if we have our own way about it, we propose to promulgate a Gospel of Good Taste and to establish tests to determine who may be admitted to the shrine as adepts and who shall be cast into outer darkness. That will keep out all those who try to be funny in the wrong place along with those who are without a proper sense of the things we like best. We propose to do this even if, in the end, we ourselves land in the outer darkness. We confess it does give us a pain when reading something serious to find a poor joke languishing alone, like the last rose of summer, to liven the text. But there is the new-Sunday-go-to-meeting-suit-of-clothes style of scientific literature that bothers us also. This is practiced by many distinguished men who do not hesitate to use as ugly a word as specificity without a thought that a sound like that is an offence against good taste.

Science suffers from the ugliness of its language. Any old word to express the meaning has been seized upon, irrespective of its artistic faults. That is because the language of science is young and has not had the time to grow civilized. We can't even agree about spelling or pronunciation. In English some of us are disposed to worry about the vowel "i," and to shorten it as often as we can. By right of custom it often holds its place in iodine, but the other halogens become "bromeen," "chlorinn," etc. Germans grow nervous over the vowel "y" and usually pronounce it falsetto. Some of us say catalyst, but others use catalyzer—which does not seem to be an improvement.

The late WILLIAM JAMES introduced slang into philosophy—and he did so to the advantage of philosophy and psychology. But he was such a master of letters that he decorated diction with slang, just as the profanity of the late Mayor LIVINGSTON MIMS of Atlanta had its own quality of elegance. It is hard to introduce these subtleties into scientific writing, for it is in the lighter steps that we are bound to show our leaden feet. The main thing in writing is to get the idea across, and we constantly urge our contributors and try ourselves to write as though we were talking to the reader, and as if both reader and writer were engaged in a pleasant

effort with all their electrons, to reach a common understanding. Bring in the Sunday School or chewing gum or mothers-in-law or goats or flappers or the Volstead act or anything else, if it will only help. But if such things serve only as unrelated contributions to the humors of science, then our friend is justified in his criticism, and they should be avoided.

Ghosh

All Hemlock

IT DOES BEAT ALL what difficulties we find in the search for the solution of solutions. When we old fellows were young, solutions were about the simplest things in chemistry: you dissolved the solute in the solvent, and there you had it. That was all there was to it. It worked perfectly so long as you didn't worry about it. Of course, as soon as people began to call for investigations as to the behavior of bodies in solution the troubles began, and a promising young fellow named ARRHENIUS, who couldn't sleep because of his questing, conceived the idea of electrolytic dissociation. In the course of time we accepted the idea, but we might as well admit that it was unwillingly done and that if it had not been for OSTWALD and VAN'T HOFF we might still be discussing the subject in the manner of Kentucky theologians and WILLIAM JENNINGS BRYAN.

But really, our thinking (which we had learned) had to do principally with dilute solutions. When ROLLO'S uncle advised him how to study chemistry the old gentleman said:

I used to think theology
Was rather rough on doubt,
But chemistry with ions beats
Theology all out.

You'd better join the church before
Your course is well begun
Because you'll need to exercise
The art of faith, my son.

Solutions you'll discuss at length,
Provided always they
Contain solute to solvent as
The needle in the hay!

There was the trouble. As long as we had a substance in solution in the relation of one small needle to one large haystack, everything went well. Concentrated solutions were a nuisance; they were solutions, all right, but they did not behave according to the rules that we had learned.

Then along came a gentleman with the most picturesque name in chemistry—so far as any one with New England affiliations is concerned. His name is GHOSH, JNANENDRA CHANDRA GHOSH, from far-away Calcutta.

Now "Gosh" is a word that has probably wandered over into colloquial English use through the medium of Sanskrit, and when we say, "Gosh all hemlock!" we indicate surprise, amazement and sometimes despair. In this solution business Dr. J. C. GHOSH became a very present help in time of trouble. While the subject was getting pretty hard for some of us, he came forward from the banks of the Hoogly with everything explained. No matter how strong the solution, said he, any dissolved salt is completely ionized, and the little ions are all arranged in orderly rows in the solution, just the same as the atoms of the same salt are arranged in the crystalline state, as recently expounded by the modest BRAGGS, father and son. That is, we were told that the ions arranged themselves in a kind of a submarine lattice formation. They are like children, we were to understand, sitting on their benches at school; at a co-educational school, in fact, because they tend to form "completely saturated electrical doublets" with their oppositely charged neighbors. But even as the course of true love never does run smooth, so some of the ions have energy enough to break away from their mates, according, by GHOSH, to Maxwell's law of the distribution of velocities. These more venturesome ones thus become the "free ions," which conduct the current, whereas the more tranquil pairs, being bound, hold fast to that which is good, refuse to be parted from one another, and so do not conduct.

Isn't that a pretty theory? And it explains everything. The trouble begins for some of us when we want to prove it, and, digging back into the storehouses of our scholarship, we find ourselves lacking in the needful familiarity with differential equations and thermodynamics and those other enticing studies which seemed too theoretical for such eminently practical men as we were resolved to be when we were young. But Dr. GHOSH, he knows mathematics backward and forward, and he adds a little to the postulates we have outlined above and digs down into the depths of his learning and brings up the expression "virial" and the formula $e^{-\frac{A}{nRT}}$ and emerges with some beautiful equations which demonstrate that everything is just as he said it was. They show perfect agreement with all the experimental results on conducting solutions that ever found their way into print. Then we admire those long and involved equations and formulas, and, like the boards of directors of some chemical works when they get a report of the progress of research, we approve, accept and place them on file. We can't follow "very well," as we admit, but we applaud. Why, not long ago the learned Faraday Society in London held a symposium on ionization, and one gentleman present declared that the theory of GHOSH marked the greatest advance in physical chemistry since the revelation of the Ostwald-Planck dilution law.

But now is our complacency sore troubled and the waves of doubt encompass us about. In the April number of the *Journal of the American Chemical Society* Prof. JAMES KENDALL of Columbia University contributes an article which attacks our faith and harasses our spirit with all manner of uncertainty. The work of GHOSH has been done after him and checked up in detail with disastrous results. The postulates prove to be inconsistent with each other. The equations do not follow from the postulates, in spite of "virial," $e^{-\frac{A}{nRT}}$ and their companions in obscurity. Worse than ever, many of the calculated results do not follow from the equations. And finally, Ghosh all hemlock, an astounding proportion of the observed results of previous investigators have suffered transmutation in the process of transcription. We know the wonderful work which the veteran KOHLRAUSCH did, and when GHOSH says his theory agrees with KOHLRAUSCH'S data, and gives tables to prove it, what room is there for doubt? None, until we are put wise to the fact that 39 out of 75 of KOHLRAUSCH'S values, as given by GHOSH, are not the same as in the original.

And so we are sent out to wander in the wilderness again! Solutions have not yet been solved after all! Ghosh all hemlock!

The Ignorant Forge Shackles for Progress

UNDER the mistaken idea that democracy consists in letting everybody decide everything for himself whether he knows anything about it or not, we have struck the severest blow to representative government that it has ever received. We have made party leadership irresponsible. Senators are now both nominated and elected by popular vote, and the quality of the Senate has gone off. And as representative government weakens under government by harangue, the always-ready oligarchy steps in and takes the reins in the disorder which follows. We have lost the checking system of government that the founders were thoughtful to provide when we let ourselves be carried away by direct nominations and threw the obligation and responsibilities of representation on the people.

The more we encourage government by speech-making the more we give up our rights and privileges as citizens and our liberties. Utterly irresponsible legislators, nominated and elected by grown-up children, and a curious group of leaders who are constantly engaged in doing battle against intelligence propose measures that take from us that which we hold most precious: our liberty of thought and of speech. The statute lately proposed in the State of Kentucky and which failed of adoption by a single vote sounds like a joke; but it is not. It isn't even funny. It proposed under severe penalties to prohibit the teaching of the principle of evolution. WILLIAM JENNINGS BRYAN has a new speech about it and he is making a profitable journey through the country, appealing to the ignorant, to deny the right of freedom in the study and teaching of geology, biology, comparative anatomy, anthropology and the whole gamut of science wherever it interferes with the exact letter of the first chapter of Genesis. The reason for this is that it does not accord with the bias of a limited number of persons in regard to what they think is religious teaching, but which is not religion at all. It does not accord with their particular dogma. That is all.

The opponents of evolution of this generation are principally those who for lack of mental capacity cannot comprehend the nature of progress. They cannot see beyond tradition. And the theory of human evolution does not include them in its workings.

The anti-evolution propaganda is no less than an effort to forbid all teaching that is not approved by a board of ecclesiastical censors drawn from the most ignorant. Objection to these amazing restrictions on freedom of thought is as common among enlightened churchmen of all denominations as it is among men of science.

Where then is the danger? It consists in our good-humored listening till BRYAN and his ilk get a following. Soon such a following will make noise enough for the weaklings nominated to legislative office to hear the sound and think it represents votes. Then, before we know it, by threats of the minority that hold these views, we find the statutes enacted, the Constitution amended—and our liberties gone.

It is time now to tell those who constantly offend against intelligence that we purpose to retain our liberties and to put ourselves to the discomfort of showing that we mean it. It is an unpleasant, noisy job, but the situation demands it. It is time for men of science to speak.

New Lines of Production Needed

ONE of the difficulties in appraising the economic needs of the present time is the distant mental vision of pre-war times. We are apt to feel, now that the war is over, that we ought to begin where we left off. We have economic problems, and those that seem to result from the war receive much attention, while little attention is given to the fact that just before the war we also had economic problems, and the war did not settle those problems.

No one wishes to start an argument as to who or what caused the war, but it is permissible to recall, merely as a convenient aid to memory, that early in the war there were cited many economic facts such as would tend to produce war. Prominent among these was what is called "overproduction," wherefor "new markets" were being sought.

It is very curious that reference to "overproduction" so frequently produces a mental concept in terms of aggregate instead of individual industries. While we have learned something in this respect in recent years, even today the thought in many minds is that the United States possesses too much productive capacity, from which some men seem to deduce that we should encourage all exports and discourage all imports.

In the early stages of any industry progress is usually slow. Then, as technique is developed, production per unit of equipment increases and costs decrease, whereby demand increases through the increasing cheapness. The owners, who are merely human beings, acquire a slightly exaggerated idea of their product's importance to mankind, and give little thought to the possibility of a saturation point. The natural result is that there is what is called "overproduction" of this commodity, which means simply that development along that line has gone too far and others that could be developed are being neglected.

In the latter part of the nineteenth century there was what was called "overproduction" in the United States and elsewhere, and the condition continued in the new century up to the beginning of the war. We should now remember that the condition, however erroneously described or misunderstood, existed before 1914—not all of our present difficulties are the product of the war.

On the contrary, the war accentuated some of the undesirable conditions that already existed, causing, for instance, the further expansion of industries that had already reached or passed the point of full development to meet the desires of the people, and furthermore the period since the beginning of the war has been singularly bare of discoveries and inventions giving men opportunity to work in producing new things that the public may want.

It would be ludicrous, if it were not tragic, how widespread is the notion that our industries are here and simply must be kept. Continually references are being made to this industry or that industry operating at such and such a percentage of its "capacity," plainly with an inference that conditions will be right and conducive to our complete and continued welfare when each industry is "operating at 100 per cent." That is altogether too easy for this world. Instead, we are lined up for more changes than ever, not merely to correct distortions produced by the war, but to correct many that had developed long before the war.

Electric Cast Iron

Symposium by American Electrochemical Society Considers Manufacture of Pig Iron in Electric Furnaces, Manufacture of "Synthetic Cast Iron" From Steel Scrap or Iron Turnings, Melting of Pig Iron by Electricity, and Desulphurizing Cupola-Melted Gray Iron

A DAY-LONG DISCUSSION on all phases of electric cast iron was held in Baltimore, Thursday, April 27, by the American Electrochemical Society. Starting with Heroult's experiments at Sault Ste. Marie, papers and contributed remarks carried the subject into nearly all corners of the field which have been explored or occupied since that time.

Smelting Furnaces

A very good case for the open-top furnace, for the production of pig iron from ore, was made out by R. C. Gosrow in a paper entitled "Shaft vs. Open-Top Electric Furnaces." Disregarding at least one intermediate type, there are two practicable ore-smelting furnaces. Shaft furnaces, either with closed or open top, are useful for drying and calcining the charge before it reaches the reduction zone. Gosrow doubts whether any reduction of ore by ascending hot gases occurs, a doubt voiced by many auditors, but it is difficult to see why this should not occur, if, as said by the author, "the stacks were constantly frozen up with the charge, which fused [sintered?] by contact with the hot exit gases." Sticky charges are associated with slips, broken electrodes and superheated and smashed linings. Variable operating conditions are furthermore caused by segregation of even a carefully prepared charge during a descent down a tall shaft, and the variable electrical conduction by irregular settlement of the charge and after molten metal is tapped from the furnace.

While F. Hodson was sure he had seen gray iron tapped from a Swedish shaft furnace, several other speakers, notably Dorsey A. Lyon, said that the product was not a pig iron, as this was known to the foundry trade, but a hybrid metal, a white iron for steel making containing 2 to 2¼ per cent C. Swedish furnaces seldom met predictions as to cost of operations, but many of their early troubles have been successfully overcome. Roof failures, near the electrodes, have been controlled by gas circulation (really the main value of this operating feature except perhaps in the larger furnaces, where a little pre-reduction may be effected thereby) and the Soderburg self-baking electrode has solved many troubles originating at the carbons. From the standpoint of comfort to the workmen, there could be no comparison—to a casual observer the Swedish furnaces do not appear to be smelting, while an open-top furnace is a good imitation of hell. This term is purely relative, however, as demonstrated by Robert Turnbull, who offered to exhibit a 20,000-kw. open-top furnace which was no more uncomfortable than a crucible melting shop. He also insisted that "hand stoking and the correcting of the position of the electrode in the charge is more than half the battle, and such work is impossible in the shaft furnace."

Turning to the merits of a rectangular open-top furnace with a shallow ore bed and of at least 7,000 kw. capacity, Mr. Gosrow pointed out that the operation could be much more closely controlled because variations in smelting rate quickly show in the conditions at the top of the charge, and the necessary correctives can be got down to the smelting zone—or for that matter, if charging is stopped the charge works down so that wall accretions can be barred off or proper flux charged alongside, or in bad cases the furnace can be drained completely in a few hours. Much stress was laid on the advantage of placing the charge just where it is wanted, with the assurance that it will not be badly segregated by the time it reaches the smelting zone, or the charcoal crushed and the charge compacted by the excessive overburden. "The initial cost of construction is lowest and the cost of maintenance is also the lowest." A detailed estimate of the smelting cost totals $40 per net ton of iron in a proposed Western plant to produce 20,000 tons a year, a cost which apparently is liberal, since Messrs. Fitzgerald and Turnbull noted that the current consumption and the electrode charges were very liberal, not to say extravagant, whereas the plant itself could probably be built for half the estimated $750,000.

Robert Turnbull noted that there was no question that the open-top furnace was economical, despite the fact that none are now in operation making pig iron. Heroult's experimental runs at Sault Ste. Marie have never been bettered, if approached[1]. The operators at Heroult, Cal., were never able to produce gray foundry iron consistently, but no trouble was experienced at the Sault, where all tappings were of gray iron with 3 to 4 per cent C.

Carburization of Iron

Whether or not the necessary balance between carbon and silicon could be attained so that gray foundry iron could be produced in a pit furnace depends to a large extent on the rate of absorption of solid carbon into molten iron, since the zone of reduction and carburization by CO gas is practically non-existent. It has also been very difficult to get more than 3 per cent C into "synthetic pig iron" made by melting iron sponge or steel scrap in an electric furnace. Furthermore, it has been found impossible to melt iron sponge in the open hearth and carburize it without melting down the roof, although it is reported that heats containing 80 per cent of "purple blocks" (briquetted sponge iron) are being melted in Sweden with the introduction of 3 per cent carbon.

Therefore, "A Study of Carburization in the Manufacture of Synthetic Cast Iron," by Clyde E. Williams and C. E. Sims, was given particular attention. Most of their experiments were made in a small tilting furnace, holding 300 lb. of metal. Mild steel punchings and clippings were mixed with about 20 lb. of carburizer (crushed through 10 mesh), melted, necessary

[1]Certain ores were smelted with 2,000 kw.-hr. per ton, whereas the best Swedish furnace uses 2,500 kw.-hr.

ferro-alloys added, and sampled periodically. Temperatures varied not more than 50 deg. during a single run, and seldom mounted higher than 1,450 deg. C.

Table I shows the results of a series of runs on various carburizers. Practically all of the carbon contained at the end of the melting stage was picked up immediately upon melting, for if steel clippings were melted before the carburizer were added, samples would analyze 2.7 per cent carbon after a few pounds of graphite was thrown in. Graphite is a better carburizer than charcoal, because it is much easier to keep it in contact with the iron. Its commercial use would be restricted by the limited amount of electrode butts available. The table also shows the advantage of using low-ash coke.

TABLE I—ABSORPTION OF CARBON IN IRON CONTAINING 2 PER CENT Si

Carburizer	At End of Melting Stage Time (Min.)	Carbon Content	At End of Experiment Time (Min.)	Carbon Content
Acheson granular resistor graphite	190	3.0	260	4.1
Coal tar coke, 4 per cent ash	150	2.5	230	3.8
Coke, 12 per cent ash	160	2.3	270	3.6
Coke, 25 per cent ash	110	2.1	300	3.0
Charcoal	130	2.2	270	3.3

Robert Turnbull made a considerable quantity of electric pig iron during the war, and found that 2½ per cent carbon was about the maximum he could introduce with lump charcoal; crushing the charcoal for better contact boosted the carbon to 3 per cent; finally, by using silicon carbide (carborundum fire sand), he was able to increase the carbon to 3½ per cent, introducing 1 per cent silicon at the same time. The present authors also find that if silicon carbide is added after high-ash coke has been used, the carbon is increased from 3.1 to 3.9 and silicon increased 1.55 in 8 minutes.

Silicon in iron up to 7 per cent and phosphorus up to 0.8 per cent apparently makes no difference in the amount of carbon dissolved, but 1.75 per cent manganese iron carburizes a little more rapidly than one containing 0.40. Sulphur uniformly retards the rate and total amount of carburization.

Slags would be expected to retard carburization by preventing physical contact, iron to carbon. This indeed occurs, except when working under a desulphurizing slag, when the iron is carburized rapidly, possibly because calcium carbide in the slag transfers its carbon to the iron more easily. George K. Elliott said that this was possibly also due to the simultaneous lowering of sulphur. At Aniston, Ala., it is the practice to "pole" the charge, or stir it with a green pole, when making electric furnace wash metal. In this way sulphur is reduced to 0.03 and carbon up to 3.9 to 4.0 is absorbed from low-ash coke with no trouble. Low-sulphur frees manganese from the sulphide and allows it to form a corresponding amount of carbide.

Carburization in the Cupola

If straight steel charges are melted in the cupola with the proper coke, the resulting iron could ordinarily be expected to contain 2¼ to 2½ per cent carbon. Six times as much coke would probably have to be burned in order to boost cupola melted steel to 3½ per cent carbon, although a mixture of scrap steel, plus a small quantity of cast iron, plus a little high-grade ferrosilicon has been used to make low-phosphorus bessemer pig containing 2½ to 3 per cent C. Richard Moldenke mentioned some recent German practice of interest in this connection, where synthetic pig iron for malleable and low-carbon (2¼ to 2½ per cent) castings are made in a cupola. The charge consists of two kinds of briquets: First, steel clippings or borings heated to redness in a rotary furnace by a strongly reducing flame, a certain quantity placed in the lower, box-like die of a forging hammer, and welded into a pancake of high density by two or three vigorous blows; second, pig-iron shot and ferrosilicon cemented into small bricks.

Synthetic Cast Iron

James L. Cawthon, in a paper on "Synthetic Cast Iron," discussed methods of applying these principles to the actual production of cast iron from machine shop scrap (steel turnings). When this is melted in either an acid or basic electric furnace with 75 lb. good coke per ton, it will come down with about 2.5 per cent carbon, and well deoxidized. Melting under a carbide slag in a basic furnace will not change this carbon analysis nor affect the manganese or phosphorus, but silicon will be reduced practically to zero, and sulphur cut in half. Acid furnace melting without slag brings down metal unchanged in S and P; about 50 per cent of the Mn has slagged, while a little silicon has probably been picked up from the furnace. If desulphurizing is unnecessary, the acid process will prove cheaper and simpler, and give less trouble with slag when pouring the iron.

More carbon can be added only by stirring carbon into hot clean metal. Cawthon recommends skimming the bath carefully, adding 50 lb. fresh coke, raising the temperature as far as the furnace will safely stand, and stirring the bath with a green pole. Ten minutes poling will increase the carbon 0.50; another equal portion can be absorbed by repeating the operation. Some silicon can be reduced from an acid slag, but ordinarily it will be cheaper to add 50 per cent ferrosilicon just before tapping. Provided two or three times as much Mn is present as is necessary to form MnS, and C is 3.25 or over, a further fractional percentage of manganese does not affect the physical properties of the cast iron materially. Ferromanganese will be absorbed by the metal quantitatively if added to a basic heat at any time; at least 15 per cent is lost when adding at the very end of an acid heat; none is lost when adding the alloy to hot metal in the ladle.

Since phosphorus is eliminated at a fairly low temperature and under highly oxidizing conditions, it will remain practically constant in a high temperature carburizing operation. If phosphorus under 0.03 per cent (washed metal) is desired, it can be had by melting steel scrap in a basic furnace, with additions of lime and iron oxide. After melting, the phosphorus slag is removed, leaving behind "wild metal," which will violently boil when the first shovel of carbon is thrown in. This boil should be checked by 3 lb. of ferrosilicon fines, whereupon carburizing can proceed in the usual way.

A useful furnace test is described by Mr. Cawthon. He casts a test bar, 1 in. diameter, 6 in. long, in a dry sand core block, it is shaken out after 3 minutes, and quenched after 7 minutes further air cooling. A fracture is studied; one break is ground and tested for Brinell hardness. If the metal is harder than experience indicates is desirable to match the specification, carbon or silicon should be raised by additions, depend-

ing upon the indications of the fracture; if the hardness is too low, more low-carbon steel scrap is added.

Field for Process

In a paper entitled "Synthetic and Electric Pig Iron Sanely Considered" Robert Turnbull expressed the opinion that notwithstanding the fact that little or no synthetic pig iron is now being made anywhere, it is a logical operation for iron foundries having electric furnaces making either gray iron or steel castings, of both; the same furnace serving for both. Indeed this exact condition at Treadwell, Alaska, was described in a paper by W. E. Cahill, entitled "Electric Furnace Iron and Steel. Intermittent and Alternating Operations."

Synthetic iron is also the best solution for the problem of producing pig iron in countries far removed from coke and producing furnaces. Iron from scrap in an electric furnace will in most cases prove far cheaper than electric furnace production of iron from ore. Despite the difficulty in charging, and in getting high carbon into a low-carbon bath, the steel furnace is to be recommended over the open-top smelting furnace, because the closed furnace is more flexible and can be operated with refining slags. Refined iron, as a matter of fact, does not need as high carbon as ordinary cupola metal.

A supply of cheap iron or steel borings is a very attractive raw material for excellent castings at a price which may compare favorably with cupola melting from expensive pig.

Melting Cast-Iron Borings

Just how cheap the electric furnace and how dear the cupola iron will be depends to a certain extent upon who makes the estimates. Disregarding some evidently erroneous figures submitted in one of the papers, E. L. Crosby told of a foundry in Detroit which could buy borings at $8 per ton and used them for 100 per cent of the charge. Their current consumption was 600 kw.-hr. per ton under 8-hour operation, or 500 to 525 kw.-hr. per ton for 16-hour operation. Paying 1.8 cents per kw.-hr., they were able to produce molten iron from borings for $23.60 per ton, whereas cupola iron, made right alongside, cost $25 per ton. This tells only part of the story, for the rejections, both in foundry and in machine shop, were sharply reduced. Consequently it would probably be cheaper to use electric iron even if the borings cost 50 per cent more.

F. W. Brooke pointed out that one feature often overlooked by furnace estimators was that material absorbed heat at different rates, and that the same material varied with its physical condition. Cast-iron borings melted particularly slowly, and were quite liable to melt from the top; whereupon the arc would melt about as much furnace as metal. This trouble is largely obviated by methods described by H. M. Williams and T. B. Terry in their paper entitled "The Melting of Cast Iron in the Booth Rotating Electric Furnace." Using a very small furnace, holding from 250 to 280 lb. metal, it is actually easier to melt turnings than a mixture of pig and scrap, possibly due to the washing action of the molten charge on the finely divided solid.

No refining is attempted; additions are made with a small spoon thrust through an electrode hole. Temperatures are regulated by watching the current input; operations having been standardized so that the furnace may be poured by wattmeter. Melting losses amount to 4 per cent on pig and scrap, and 7 per cent on clean borings. No material change in chemical analysis is noted, except sulphur goes up about 0.01 per cent, either from a habit which sulphur has, errors in sampling, or dirt or cutting oils adhering to the scrap.

Duplex Foundry Iron

George K. Elliott reviewed the foundry practice of duplexing with cupola and basic electric hearth. Small heats of special iron may advantageously be melted in the electric furnace, but since the cupola is able to melt 8 tons of iron with 1 ton of coke, there are few locations where electric energy can compete. A cupola is a wonderful melter, but it introduces 0.03 S into iron on each melting, and in careless hands will deliver highly oxidized and gassy metal. Whenever these limitations of the cupola, or the cost of available raw materials, or the shifting from price per pound to quality per piece, or all of these factors together, become of considerable importance, a basic electric furnace should be introduced to refine the molten iron delivered by the cupola. Cast iron can be deoxidized and sulphur reduced from 0.18 per cent to under 0.07 in about 30 minutes, changing poor castings into uniformly good ones. Some 0.15 S irons, even some 0.25 S irons, produce acceptable test-bars, especially in England, but at the Lunkenheimer plant in Cincinnati it has been found that an important machining operation invariably uncovers "dirty" iron whenever S exceeds 0.09 per cent. Mr. Elliott was of the opinion that impact testing should be used to determine quality on apparently similar irons; a certain obsolete casting was scrapped, and several made of duplex metal and several of cupola metal of substantially the same composition and tensile properties were broken under the drop hammer. Cupola iron broke in two drops; electric iron required four or five drops.

Foundries serving machine shops where intensive production programs are installed should be particularly interested in electric duplexing, since it will enable them to produce unfailingly material of uniform machinability and strength. In figuring the value of the process, one should not reglect the important saving effected through a very much smaller proportion of rejected pieces, especially partially machined pieces. Very hot electric iron means sounder iron, because fluid iron in gates and sinkheads can more effectively "feed" the casting, and the ferrostatic head more effectually prevents liberation of the small amount of residual gas in refined metal. One important point is this—that hotter iron requires more refractory molding sand. While there is little information on the effect of O,N,CO,CO_2 and other gases in cast iron, the influence of oxygen and oxides on the whole is bad, since a certain well-defined kind of bad iron from cupolas is doubtless the result of highly oxidized conditions. Some of these gases may have an indirect effect in causing coarse crystallization and copious deposition of graphite in large flakes; micrographically electric iron is finer grained, the graphite comes down in smaller and more advantageously dispersed particles. Hence the iron may carry more silicon without the usual softening and loss of strength. It has already been noted that desulphurized steel is relatively easy to carburize into synthetic pig; possibly this is more truly due to the previous degasification which is essential before desulphurization is possible, and of which desulphurization is the only indication now furnished by chemical analysis.

Handling the Finished Products of Industry—I

The Necessity for Keeping the Cost of Handling Finished Products at a Minimum—Other Factors Causing the Adoption of Mechanical Equipment for Handling Finished Products—Classification of Handling for Finished Products—Types of Equipment Available and How Used

By G. L. MONTGOMERY

THAT the cost of most products is almost directly proportional to the cost of handling the materials of their manufacture into the works, through the process, and out of the works again, as recently stated by Herbert Blyth,[1] is a fact too evident to require much proof. Over any reasonable period of time, the reductions in cost possible of attainment through reduction in the cost of raw materials, of productive labor, of office and sales overhead, or of fixed charges will be relatively small as compared to reductions in cost possible through the elimination of non-productive labor. In almost any process industry, the greater part of the non-productive labor is entailed in handling the materials. The obvious and true conclusion to be reached in seeking to reduce costs is that the handling routine must be made as nearly automatic as possible so that the costs for this work are at a minimum. This solution is well worthy of adoption and should be put into effect wherever possible. Putting it into effect means the use of material-handling machinery and of other automatic machinery in the process and elsewhere.

Where Automatic Equipment Will Give the Quickest Results

Accepting the statements in the preceding paragraph as a basis for a study looking to the reduction of the costs of producing a commodity and getting it into the hands of the primary consumer, let us survey the present use of automatic equipment for handling and other purposes in the process industries, and determine where in these industries such equipment can be made to give the quickest and most satisfactory results for the least expenditure of capital.

As stated above, this automatic equipment is concerned with getting the materials into, through and out of the plant. In this series of papers equipment is considered as handling equipment whenever it is employed to further the physical movement of the material from the start of the process toward the close. Hence such machines as are commonly called automatics—i.e., cutting, wrapping, bagging, filling and packing machines, etc.—are here included as handling machines, together with the conventionally so-called conveyors, trucks, cranes and so on. Consideration of the three steps—in, through and out—will show where an industry can best start to realize the savings possible if there is no handling equipment employed or where perhaps, if some handling equipment is used, an extension can best be made to give quick results in reducing costs.

The application of automatic machinery to the movement of the raw materials of industry has had a more extended development and has been more widely accepted by the process industries than any other type of handling. Types of conveyors for this purpose such as scraper, drag, apron, belt and bucket, bucket-elevators, and cranes and hoists have reached a state of workability almost approaching perfection, having had their development many years ago in mine and power house. From the ancient mine car drawn by a pony the electric industrial railway and the storage battery or gasoline-motored industrial truck have grown. Locomotive cranes, bridge cranes and similar devices were early used in mines, coal-storage yards and such places. From these uses this equipment has spread to industry in general. At the present time its acceptance and use is on the road to universality.

Of course there are a number of cases where the raw materials are not handled by automatic equipment. Generally it will be found that these cases are where the total amount to be handled is small, or where, while the aggregate may be large, it is made up of a number of diverse materials which for some reason must not be mixed or contaminated one by another. In these cases study has generally proved that the saving incident on the use of handling machinery would not offset the relatively high fixed charges on the installation necessary.

The Status of Inter- and Intra-Process Handling

Mechanically handling materials while they are in process of manufacture is of great importance. No one other thing can have as great an effect in reducing costs of production, increasing production efficiency and lessening the problems of management. Without question, in cases where a new plant is to be erected, new machinery is to be purchased or existing machinery is to be re-arranged, the most complete system of inter- and intra-process handling and the fullest use of automatic process machinery that sound engineering judgment and practical designing and operating experience can recommend will be found a highly paying investment.

But the efficient use of such equipment almost invariably requires an arrangement of process machinery differing from that used with man-power handling and often requires the development of new machines or appliances. These considerations put a necessary brake on any sudden and universal realization of increased production efficiency through extensions of this type of handling. Such a growth will come—but come slowly—as new processes are developed, new plants are erected and existing equipment, through obsolescence, requires replacement.

The Finished Products Present the Best Field for Immediate Savings

Taking the product out of the plant includes all operations which must be performed with a product after the last true manufacturing process is completed, until it

[1] *Chemical Age* (London), Feb. 25, 1922, abstracted in Chem. & Met. Eng., April 5, 1922.

passes out of the ownership of the maker. These operations are really incidental to the distribution and sale of the product, including such items as wrapping, storing, packing, labeling and shipping. Often the cost of this work more than equals all the other charges which the product must bear. It is obvious that any savings that can be made here have a direct result in reducing the price at which the products can be sold and hence enable the sales force to do more effective work. If these savings are made in many industries, the consequent price reductions possible, covering a broad field, cannot fail to stimulate trade—domestic and foreign.

The cost of handling finished products is generally regarded as a necessary evil. Part of this cost is necessary. But the effort to reduce it to its irreducible minimum has just started. Everywhere one sees work of this nature being done by hand, utilizing the labor of hordes of workers, workers who could be and should be trained to real productive labor if it were possible to spare them from their present non-productive tasks.

And it is possible so to spare most of them; but not until the automatic equipment has been installed to take their places. Packing and shipping rooms, distributing warehouses, storehouses, piers, railroad freight terminals and all kindred places in which this non-productive work is performed can get along with fewer workers and do their work in a more efficient, quicker and cheaper way by the use of machines and equipment which has already been thoroughly tried. As an illustration of the difference which the use of such equipment makes, the writer was recently on the freight pier of the Hudson Navigation Co. in Albany, N. Y. The tractors usually employed in loading and unloading the boat from New York City were undergoing their annual overhauling and as a result it had been found necessary to hire more than fifty additional men to handle the work usually done by the tractors and their trailers. This meant that the force on the pier had been more than doubled, conditions being back to the same state as before the tractors had been purchased. The agent of the company stated that the equipment had more than paid for itself in a year and had been a great help to the company in getting its work handled expeditiously.

This equipment is all susceptible of improvement and is constantly being improved. But as it exists today, the results obtained by those who use it warrant full investigation on the part of those who are still using hand methods and justify the statement that the use of automatic equipment for handling finished products is a necessity for those who wish to keep costs low for competitive reasons and still to make a fair profit.

Other Reasons for Using Automatic Methods

Aside from the direct economies to be realized in the use of automatic handling methods for the finished products, there are several additional reasons which make the use of these methods at least advisable. Among these we might mention the elimination of delays obtained by having a continuous flow of product to the desired point at the desired time. Confusion is also eliminated in packing, warehouse and shipping rooms because of the smaller number of workers and the direct pathway which the products take. And also there is a speeding up of the workers without increase in fatigue, made possible by the greater ease of accomplishing the work and the natural human inclination to keep the pace of the machine.

These three factors all have a direct and an indirect effect in lowering costs and increasing efficiency of production, which may be decisive factors in causing the adoption of mechanical equipment. In addition, one result of eliminating delays and confusion, of speeding up the workers and reducing the working force is to do away with much of the burden of management. The first result of this is to make it less difficult to keep the work going smoothly. Following this, ways will be found for economies in the office overhead, and the ultimate result is a further reduction in the price at which the product can be marketed.

Hygiene and Cleanliness as Factors Causing the Use of Automatic Equipment

Often the product of a process industry is one where the conditions of manufacture must be kept at the highest attainable point of sanitation, as for instance with a drug or a food product. This naturally means that the surroundings must be as clean as possible, and all contact between the product and the workers reduced to zero or thereabout. There is only one way in which this can be done—by the fullest use of automatic machinery and mechanical handling equipment that can be reached. This consideration of cleanliness applies more to the finished products than to other phases of the industry, for there is no further possibility of sterilization or purification after the process is completed. Any contamination which may occur in wrapping, packing or shipping or other operation which the finished product undergoes has a direct effect in lowering the sale value of the product and hence increasing the relative cost of production.

Psychological Effects of Automatic Machinery

Two other effects of installing mechanical handling for finished products, which are largely psychological, are worthy of note. These are, first, the improvement in the morale of the employees resulting from easier working conditions, lack of confusion, and cleaner, pleasanter surroundings. And, second, the fact that a completely mechanized plant can be made a showplace, and for the public to see a food product or similar article packed and handled in a spotless plant without contact of human hands has a distinct reflection on sales.

Classification of Handling for Finished Products

Handling performed on finished products can be divided into three general classes. First, where the product is in a bulk or unpacked state. In this condition it is least convenient for manual handling; and for cleanliness and many other reasons, it is most necessary to have the handling done by machine. Second, after the product has been wrapped, boxed or crated, or otherwise prepared for shipment and has reached the point where it must be moved through various storing and shipping operations. And third, an intermediate class of handling, coming between the first and second classes, where the bulk or unwrapped product is put into the final container or form in which it is to reach the consumer.

Of the above, the second class presents the place in which handling equipment can most easily be installed and in which the cost of the installation will be least. It is often possible, by the application of a small gravity or belt loader or a storage conveyor or an industrial

truck, without any great change in existing conditions, to effect a revolution in this second class of handling. In most industries, and in the small plants of these industries in particular, this is the place in which the installation of modern handling methods should be started.

In the first class mentioned, handling equipment may be effective in reducing labor and always produces good results by feeding the wrapping or packing operations in a properly continuous manner and eliminating confusion and easing the task of keeping the plant clean. By doing away with the necessity of keeping a large working margin of bulk or unpacked material at the packing room, this type of handling is valuable as a space saver. The equipment used here is often much more costly and heavier than that used in the second class, but its use pays dividends and is absolutely necessary to make a well-rounded system that will give satisfactory results.

In the third or intermediate class, the machinery consists of what is usually known as automatic machinery. This is as truly handling equipment as any other class of handling machinery, for by it the product is moved through a series of operations, and the moving element of the machine is always some true conveyor element as a chain, roll or belt. Such machines are usually a combination of several operations and the movements between them—all in one machine.

This machinery is not applicable to every industry, not being needed in some—as in the brick industry, where a common red building brick after it is burned undergoes no operation to which an automatic machine could be applied. But the use of these machines has not yet been extended to many of the industries where they could effect marked savings, while in those industries where this machinery is already developed its use has not yet fully spread through the industry.

Standard Types of Equipment and Where Used

Class 1. Handling equipment for finished products in bulk or unpacked form:

(*a*) Flat belt conveyors.
(*b*) Troughed belt conveyors.
(*c*) Bucket elevators—various types.
(*d*) Screw conveyors.
(*e*) Apron and pan conveyers.
(*f*) Slat conveyors.
(*g*) Scraper and flight conveyors.
(*h*) Drag chain conveyors.
(*i*) V-bucket and pivoted bucket elevator conveyors.
(*j*) Cranes, hoists and monorails.
(*k*) Storage-battery or gasoline-motor driven industrial trucks and tractors.
(*l*) Lift trucks—hand or power propelled.
(*m*) Compressed air conveyors.
(*n*) Pumps—all types.
(*o*) Industrial railways.

Class 2. Handling equipment for finished products in various kinds of containers, or on platforms or palettes:

(*a*) Gravity roller conveyors.
(*b*) Spiral chutes.
(*c*) Straight slides.
(*d*) Apron conveyors.
(*e*) Slat conveyors.
(*f*) Bar conveyors.
(*g*) Chain conveyors.
(*h*) Flat belt conveyors.
(*i*) Inclined package or barrel elevators—bar, slat or apron type.
(*j*) Vertical package elevators and lowerators.
(*k*) Storage-battery or gasoline-motor driven industrial trucks and tractors.
(*l*) Lift trucks—hand and power propelled.
(*m*) Tiering machines—self-propelled and hand-propelled.
(*n*) Cranes, hoists and monorails.
(*o*) Industrial railways.

Class 3. The automatic machines which handle the product in such operations as cutting, filling, wrapping and packing vary with every case and are impossible to name. They are generally the result of design growing out of special studies and experiments with the particular product and process to which they are to be adapted.

These automatic machines, however, well repay the money, time and effort which their development demands. Often the labor force necessary to wrap a certain number of packages is cut two-thirds by the introduction of such equipment, while the cost of the operation is cut in half. Also, where freedom from contact with the workers is a desideratum for hygienic and sanitary reasons, these machines are a necessity. Other industries have a product that is of a form extremely difficult to pack by hand, as for instance a fine dust or a sticky, gluey mass. In these cases the automatic machine is also of great use. And where the product is dangerous or injurious to the workers, the automatic machine is a necessity for safety's sake.

Illustrations of the Use of This Equipment

In succeeding articles of this series various commercially successful installations of different types of handling equipment used in handling the finished products of industry—such as are mentioned above—will be described. The facts governing the selection of the particular type of equipment used will be pointed out. In all cases where such information is available, the savings effected in costs and the improvements made in the efficiency of the operations due to the use of the equipment will be brought out. By this means it is hoped to point the way to those wishing to realize the economies which have been obtained by others through the use of proper handling equipment, and to establish some criteria by which a handling installation can be judged.

Copper Salts Improve Casein Glue

It has been found that copper salts added to casein glues greatly increase their resistance to moisture and also make them more durable when exposed to the action of molds and fungi.

In the preparation of copper-casein glue at the Forest Products Laboratory, Madison, Wis., 2 to 3 parts by weight of copper chloride or copper sulphate are dissolved in about 30 parts of water and are added to every 500 parts of the ordinary casein, lime and water-glass glue. Copper added to the casein before the lime and water-glass is ineffective.

Glues containing little lime are especially improved by the addition of copper. A low-lime glue with copper may be as resistant to moisture as a glue with more lime in it, and copper does not shorten the "life" or period of workability of the glue so much as more lime would.

Some Facts About Residual Alum in Filtered Water

Graphic Representation of Chemistry of Alum Coagulation Process Emphasizes Interdependence of Various Equilibria and Importance of Hydrogen-Ion Concentration—Use in Explaining Discrepancies in Data on Alkalinity Changes and Residual Alum

BY A. M. BUSWELL AND G. P. EDWARDS
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VARIOUS material (references 1-13 inclusive) is available in the literature which indicates certain wide limits within which aluminum will be more or less completely precipitated and beyond which it will be partly or completely dissolved. The work of Hildebrand[1] long ago indicated the importance of using the hydrogen electrode for the investigation of certain types of chemical reactions. Later Blum[2] applied this method to the study of determination of aluminum in quantitative analysis. He showed that if the p_H were adjusted to from 6.5 to 7.5 and the reaction mixture then boiled, he obtained complete precipitation—i.e., less than 0.1 mg. in 100 c.c. of the original solution. Since NH_4OH was used as the alkali, heating must have affected the final p_H. Altogether it is evident that Blum's conclusions do not necessarily apply to the precipitation of $Al(OH)_3$ in small quantities in the cold.

In September, 1920, this laboratory undertook an investigation of the various reactions involved in water purification, using the hydrogen electrode as the principal means of carrying out the investigation. The results[3] of this investigation showed among other things that p_H determinations alone were not sufficient for determining the optimum conditions for precipitation of aluminum hydroxide. A different laboratory method of attacking this problem was therefore decided upon.

Since the laboratory procedure chosen was one which involved considerable labor, it seemed advisable to make a field survey of various filter plants in the state in order to estimate the possible practical value of more exact information concerning the conditions for the precipitation of $Al(OH)_3$. It is this field survey which constitutes the subject of the present paper.

Since the completion of the first stage of the investigation two articles have appeared by Wolman and Hannan[14, 15] which furnish a very complete review of the current scientific literature having a bearing on the alum-precipitation question. These authors in their experimental part confirmed the statements of Blum, Mahin and others to the effect that aluminum hydroxide is appreciably soluble at a p_H of 8 or more, probably existing as the acid ion. They further showed that by acidifying their reaction mixture as Blum did to a p_H of about 7 a more complete precipitation was effected. Pirnie[16] has discussed the colloid chemistry of water purification and the relation between alkalinity and coagulation, and Eddy[17] has presented the possible applications of the p_H determinations to filter plant control.

EXPERIMENTAL

The data described in this paper were collected by visiting over twenty filter plants in different parts of Illinois. Due to irregularities in operation at the time of the visit some of the results had to be discarded. The data on twenty-one plants are given. The determination of alkalinity, free CO_2 and p_H were made in the field, while at the same time samples were collected and shipped to the laboratory for the determination of aluminum and iron.

METHODS

The determinations of alkalinity and free carbon dioxide were made according to standard methods. Hydrogen-ion concentrations were determined with the use of Clark's indicators and buffer solutions. The analysis of aluminum, iron and phosphorus was made on the residue from a 2-liter sample, which was taken up in hydrochloric acid, separated from silica by filtration and precipitated with NH_4OH according to Blum's method.[2] The ignited precipitate was Al_2O_3, Fe_2O_3 and P_2O_5. Iron was determined colorimetrically according to U.S.P.H. Standard Methods of Water Analysis[18] and phosphorus was estimated colorimetrically by a method given by Deniges,[19] which is briefly as follows: If an acid solution of $SnCl_2$ and an acid solution of $(NH_4)_2MoO_4$ are added to water containing small amounts of phosphorus, a blue color is produced, the intensity of which varies with the amount of phosphate present. These colors may be compared with standard phosphate solutions.

Aluminum was calculated from the difference between the iron and phosphorus and the aluminum, iron and phosphorus.

Reference to such authorities as Aberhalden,[20] Richter[21] and Prideaux[22] indicates that hæmatoxylin is an indicator changing color with the p_H. Hence its use in the aluminum determination would be possible only in a buffered solution. This is accomplished in a measure by blowing breath (CO_2) into the solution or acidifying with acetic acid as recommended by Richards.[23] In addition hæmatoxylin gives various colors with most of the heavy metals. Morison[24] states that "using pure hæmatoxylin a red color was given by the raw water and by a water completely clarified by a dose of alum just sufficient," and Wolman and Hannan[14] state that treated water "showed the usual alumina blue changing to brown with acetic acid." Richards states, however, that the test may be made only in an acid solution in order to avoid the color produced by the alkaline earths. In view of these considerations, the "logwood" or hæmatoxylin test was not used.

TREATMENT CHANGES IN ALKALINITY AND p_H

The chemical reactions taking place during coagulation have from time to time been represented in text books and technical articles by various styles of chemical equations. All of these show in the main that 8 mg. per liter of alkalinity will react with 1 grain per gal. of filter alum, forming $Al(OH)_3$. Now, as is very well

known, none of these reactions go to completion, but we have instead a number of reversible reactions each of which depends for its final equilibrium upon all the others. Such complex systems seem to be best represented graphically by the method used by Smith[25] as shown in Fig. 1.

The heavy arrows indicate the direction of the predominating reaction. The substances toward which the light arrows point will be present in relatively small amounts. It should be recalled in this connection that

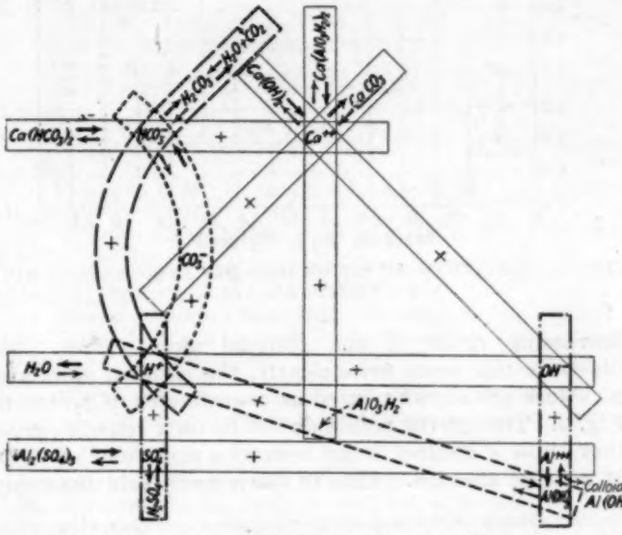

FIG. 1—GRAPHIC REPRESENTATION OF REACTIONS TAKING PLACE DURING COAGULATION

any secondary reaction which tends to remove a product of a primary reaction will increase the amount of the primary reaction in the direction of the formation of the removed product. Numerical coefficients such as are used in "balancing" ordinary chemical equations have been omitted to avoid complicating the diagram. This formulation shows the interdependence of these reactions. It also emphasizes that in each of these equilibria the hydrogen ion plays a part either directly or through its reciprocal relation to the hydroxyl ion. The relation between alum and alkalinity is shown here as in other representations, but it also appears that the loss of CO_2 with the precipitation of $CaCO_3$ may cause a decrease in the alkalinity, and that the addition of lime may cause a net decrease in the alkalinity due to this same precipitation of $CaCO_3$. On the other hand, the formation of colloidal alumina instead of the precipitate would tend to offset the decrease in alkalinity.

TABLE I—ALKALINITY AND p_H CHANGES IN FILTRATION

	Alkalinity		Decrease		p_H	
Town	Raw	Filtered	Found	Calculated	Raw	Filtered
1	56	62	−6	−12	7.8	8.1
2	116	110	6	5.6	8.3	7.7
3	178	170	8	11.2	8.3	7.5
4	192	186	6	8.0	8.0	7.5
5	180	176	4	8.8	7.6	7.5
6	79	84	−5	2.96	7.5	7.5
7	134	116	18	14.80	8.0	7.4
8	...	124	...	...	...	...
9	126	112	14	−1.4	7.9	7.3
10	130	108	22	22.4	7.9	7.3
11	160	154	6	21.6	7.3	7.2
12	68	58	10	7.2	7.5	7.1
13	82	71	11	12.0	8.1	7.0
14	58	54	4	3.68	7.5	6.9
15	132	94	38	24	7.9	6.8
16	48	42	6	16	7.2	6.8
17	54	24	30	16	8.4	6.2
18	46	24	22	12.0	8.5	6.2
19	60	16	44	0.8	7.2	6.1
20	24	2	22	16.8	6.8	6.0
21	...	6	..	.....	...	...

An inspection of Table I shows examples of all three of the above-mentioned cases. At four out of nineteen of the plants studied (2, 10, 13, 14) the decrease in alkalinity corresponded to 8 mg. per liter per grain per gal. alum used. At nine plants (1, 7, 9, 12, 15, 17, 18, 19, 20) the decrease in alkalinity was greater than the calculated. This group includes, as would be expected, the three plants at which lime as well as alum was added. At six plants the decrease was less than the calculated.

In addition to those already mentioned we submit the following list of factors which would tend in a measure at least to produce the deviations cited above. Decrease in alkalinity would be caused by: Removal of colloidal iron and aluminum hydroxide and carbonates; removal of alkaline turbidity; titration error caused by adsorption of acid on colloids during titration (Pirnie[26]); excessively acid alum. Factors tending to offset the decrease in alkalinity are: Use of basic alum; precipitation of basic aluminum sulphate instead of aluminum hydroxide; resolution of $CaCO_3$ previously deposited on the sand.

Residual Alum

Reference is made by Wolman and Hannan,[24] Pirnie,[26] Eddy[27] and others to "residual alum" in filtered waters without any statement as to the comparative amounts in the raw and filtered water nor any indication as to what may be a safe limit for this residual alum. The incrustation of sand and distribution mains and the possible adsorption on bacteria (Pirnie[26]) thereby protecting them from subsequent chlorination seem to be the chief objections to "residual alum." Unprecipitated alum has presumably done no work and the inference is that residual alum is an indicator of faulty operation and poor clarification.

TABLE II—R_2O_3 IN RAW AND FILTERED WATER, MG. PER LITER

	Al_2O_3			Fe_2O_3		
Town	Raw	Filtered	Decrease	Raw	Filtered	Decrease
1	1.36	1.86	−0.50	0.14	0.14	0.00
2	20.56	1.5	19.06	0.00	0.0	0.00
3	3.19	2.15	1.04	0.14	0.0	0.14
4	1.81	2.1	−0.30	0.14	0.0	0.14
5	1.36	1.72	−0.36	0.14	0.28	−0.14
6	1.75	1.39	0.36	0.00	1.96	−1.96
7	1.21	1.51	−0.30	0.14	0.14	0.00
8	....	1.86	.....	....	.....	....
9	2.23	1.25	0.98	0.00	0.00	0.00
10	1.56	1.12	0.44	0.14	0.28	−0.14
11	2.95	1.38	1.57	0.00	0.42	−0.42
12	0.97	12.1	−11.13	0.28	0.00	0.28
13	1.6	1.35	0.25	0.00	0.00	0.00
14	0.76	1.26	−0.50	0.14	0.14	0.00
15	0.82	0.71	0.11	0.28	0.14	0.14
16	2.30	0.71	1.59	0.85	0.14	0.71
17	0.40	3.16	−2.76	0.28	0.994	−0.714
18	0.71	0.17	0.54	0.14	0.28	−0.14
19	3.22	0.66	2.56	1.43	0.14	1.29
20	0.15	0.55	−0.40	1.68	0.71	0.97
21	....	0.16	.....	....	.....	....

Table II furnishes a notion of the extent to which alumina is present in the effluent of twenty-one filter plants in Illinois. In addition to the description of methods given above it should be stated that in all cases except No. 2 the raw water was filtered through Whatman No. 50 filter paper before making the aluminum determinations. Since a comparison of the aluminum in solution or in a fine colloidal state in the raw and treated waters was to be made, it seemed best to exclude the filterable turbidity. The data on No. 2 indicate what the results might have been without the adoption of this procedure. Nos. 12 and 17 are excluded from consideration, since they showed a turbidity in the filtered water of 30 and 25 respectively. Column 2 shows that in only the two abnormal cases, Nos. 12 and 17, does the alumina in the filter plant effluent exceed 2.15

mg. per liter (approximately ⅛ of a grain per gallon), and further that in thirteen out of nineteen cases the aluminum is distinctly less in the effluent than in the raw water after filtering through filter paper. It should also be noted that although a fairly wide range in p_H value is exhibited by these waters, in no case does the alumina in the effluent reach zero. From our knowledge of the individual plants and their operators we do not feel that this last result can be laid to faulty operation.

From the above data it appears that with reasonably good operation the amounts of "residual alum" occurring in filter plant effluent in Illinois are not such as to be the cause for alarm. Whether or not the condition of the "residual alum" is such that it is more subject to subsequent deposition or adsorption is a question for further study.

Relation of p_H to "Residual Alum"

In the diagrammatic representation of the chemical reactions given above it will be observed that the substances H^+, $AlO_2H_2^-$, $Al(OH)_3$, Al^{+++} and OH^- form a cycle. The reactions may be made to take place in either direction around this cycle depending upon the concentrations employed. Suppose, starting with the substances in the cycle in equilibrium, we take away hydrogen ions; more water will be ionized by the reaction from H_2O in the direction of the light arrow. But this will increase the amount of OH^- present, thereby causing the reaction to go in the direction of $Al(OH)_3$ and removing some of the Al^{+++} from the solution. If the hydrogen-ion concentration is depressed low enough, reaction will take place counter-clockwise in the direction of the light arrow from $Al(OH)_3$ to an appreciable extent, forming some aluminate ion with the side reaction forming some $Ca(AlO_2H_2)_2$. (The aluminate is written in the hydrated form.) If now the hydrogen-ion concentration is increased, the reaction will be turned in a clockwise direction, aluminum will be reprecipitated and later dissolved as Al^{+++}. The exact hydrogen-ion concentration at which the maximum amount of $Al(OH)_3$ is precipitated has not yet been determined. We believe, however, that we are approaching it by slow degrees.

Table III presents a summary of the data collected, the filter plants being arranged in the decreasing order of the effluent p_H values. From column 3 it is seen that with exceptions of Nos. 12 and 17 they also fall in the decreasing order of the residual alum values. To illustrate this point more clearly, the residual alum and p_H values are shown plotted as co-ordinates of points in Fig. 2. Though the points do not lie on a smooth curve, they show a distinct trend toward a minimum of Al_2O_3 at a p_H of about 6. This is much more acid than any value heretofore reported. It is, however, the first value to be determined under operating conditions and with a gravimetric estimation of the Al_2O_3.

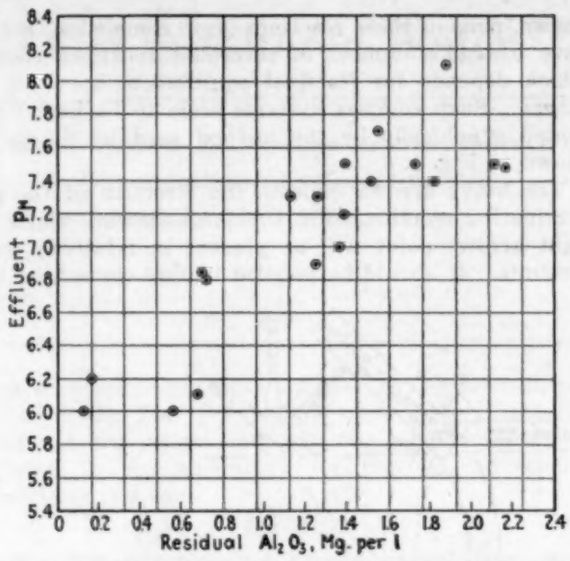

FIG. 2—RELATION OF HYDROGEN-ION CONCENTRATION TO RESIDUAL ALUM

TABLE III—SUMMARY OF DATA

Town	Turb.	Filtered Fe_2O_3	Filtered Al_2O_3	Filtered p_H	Filtered CO_2	Filtered Alkalinity M.O.	Filtered Alkalinity Ph'th	Pre-treatment Chemicals Gr. per Gal.	Pre-treatment Time Hr.	Raw Fe_2O_3	Raw Al_2O_3	Raw p_H	Raw CO_2	Raw Alkalinity M.O.	Raw Alkalinity Ph'th
1	5	0.14	1.86	8.1	0.0	62	2	0.75 alum 0.75 lime	1 1	0.14	1.36	7.8	2.0	56	0.0
2	0	0.0	1.5	7.7	2.8	110	0	0.7 alum	2	0.00	20.56	8.3	0.0	116	5.00
3	3	0.0	2.15	7.5	6.8	170	0	1.4 alum	3½	0.14	3.19	8.3	0.0	178	16.0
4	5	0.0	2.1	7.5	7.6	186	0	1.0 alum	3	0.14	1.81	8.0	2.0	192	0.0
5	3	0.28	1.72	7.5	7.2	176	0	1.1 alum	¼–½	0.14	5.9	7.6	4.8	180	0.0
6	10	1.96	1.39	7.5	4.0	84	0	0.37 alum	3	0.00	1.75	7.5	4.4	79	0.0
7	10	0.14	1.51	7.4	8.8	116	0	1.85 alum	1½–2	0.14	1.21	8.0	2.0	134	0.0
8	3	0.14	1.86	7.4	6.0	124	0	0.7 alum	6	....	....	....	....	....	....
9	3	0.00	1.25	7.3	7.2	112	0	2.8 alum 1.0 lime	4½	0.00	2.23	7.9	2.4	126	0.0
10	0	0.28	1.12	7.3	8.8	108	0	2.8 alum	6–24	0.14	1.56	7.9	2.8	130	0.0
11	10	0.42	1.38	7.2	13.6	154	0	2.7 alum	4–5	0.00	2.95	7.3	12.0	160	0.0
12	30	0.00	12.1	7.1	6.4	58	0	0.9 alum	4	0.28	0.97	7.5	2.4	68	0.0
13	5	0.00	1.35	7.0	9.2	71	0	1.5 alum	¼	0.00	1.6	8.1	0.00	82	0.0
14	20	0.14	1.26	6.9	10.4	54	0	0.46 alum	none	0.14	0.76	7.5	4.0	58	0.0
15	3	0.14	0.71	6.8	15.2	94	0	3 alum	8–24	0.28	0.82	7.9	3.6	132	0.0
16	3	0.14	0.71	6.8	10.0	42	0	2 alum	none	0.85	2.30	7.2	4.0	48	0.0
17	25	0.994	3.16	6.2	23.6	24	0	2 alum	3½	0.28	0.40	8.4	0.0	54	
18	3	0.28	0.17	6.2	19.6	24	0	1.5 alum	4	0.14	0.71	8.5	0.0	46	5
19	3	0.14	0.66	6.1	33.2	16	0	0.4 alum 0.5 lime	3 3	1.43	3.22	7.2	6.8	60	0.0
20	5	0.71	0.55	6.0	23.2	2	0	2.1 alum	6–7	1.68	0.15	6.8	6.8	24	0.0
21	3	0.14	0.16	6.0	37.2	6	0	4.5 alum	2						

Summary

The chemistry of the alum-coagulation process is represented by a diagram which emphasizes both the interdependence of the various equilibria involved and the importance of the hydrogen ion.

Data on the alkalinity changes during treatment do not check with expected changes as ordinarily calculated. Various reasons for these discrepancies are discussed.

Data presented indicate in general less dissolved alumina in the effluent than in the influent. The amount of alumina in the effluents did not in general exceed 2 mg. per liter.

Points plotted with "residual alum" and p_H values

as co-ordinates indicate a minimum alumina at a p_H of 6, which was the lowest value reached in this series.

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Motor Fuel Should Be Basis of Evaluation of Shale Oil

Attempts to evaluate shale oils, even for comparative purposes in the laboratory, involve both technical and economic considerations. From a technical standpoint one must consider and determine what possible products can be reasonably expected from shale oils. From the economic side there must be considered which of these possible products will be in greatest demand and how cheaply they can be placed on the market. Possibly in some sections of the country certain products will be in greater demand than in others; and a discussion of how cheaply these products can be produced and marketed leads to a consideration of plant location, transportation, labor supply and similar economic factors, which each plant must individually solve.

Inasmuch as the chief problem in the oil-shale work of the U. S. Bureau of Mines is to determine the conditions most favorable for the production from different shales of highest yields of best products, it must first consider what these products are likely to be; second, determine the amount of these products in the oils under consideration; and finally, determine the relative qualities of these products from different shales.

During the past several years the petroleum products in the greatest demand have been motor fuels, illuminating oils, lubricants and fuel oils. The demand for illuminating oils is increasing very slowly, and no immediate appreciable increase can reasonably be expected. Lubricants will probably be supplied from petroleum for a great many years, since much of the petroleum and petroleum residuums now burned as fuel can be worked into lubricants when the demand for lubricants increases. Oil will continue to be used as fuel until its price exceeds that of an equivalent amount of coal. The demand for motor fuel is, however, likely to grow at an increasing rate. This being the case, it seems likely that, first of all, shale oil will be used as a source of motor fuel, and secondly, possibly as a source of fuel oil. Other products will probably be of secondary importance, and it has been finally decided that shale oils may reasonably be evaluated on the basis of the amount and quality of motor fuel they will produce.

Determining Penetration of Wood Preservatives

The effectiveness of any wood-preservation treatment is measured very largely by the depth to which the preservative penetrates. This can be determined by the following tests, which are used by the Forest Products Laboratory, Madison, Wis.

The presence of creosote oil is indicated by the dark discoloration, and the degree of penetration may readily be determined by taking a sample at a point free from checks and other imperfections and at a considerable distance from the end. This may be done either with an ordinary ½-in. bit or with an increment borer, which brings out a core of wood that shows in cross-section the depth of penetration and is easily examined. The observation should be made at once, because the oil spreads rapidly over the cut surface. In order to prevent infection, the hole in the treated piece should be tightly closed with a creosoted plug.

As zinc chloride is colorless, the depth of penetration of this preservative must be ascertained by chemical means. After cutting the stick in two or getting a sample with the increment borer, the freshly cut surface is dipped for not to exceed 10 seconds in a 1 per cent solution of potassium ferrocyanide, and the excess solution is removed by blotting paper. The sample is then dipped into a 1 per cent solution of uranium acetate and dried. The treated portions will be whiter than the natural wood, and those untreated will have a dark red or a maroon color. This method does not give very sharp contrasts on wood which is reddish in color, like red oak, but otherwise is very satisfactory.

Another method consists in spraying over the freshly cut surface a mixture of equal parts of 1 per cent potassium ferricyanide solution, a 1 per cent potassium iodide solution and a 5 per cent solution of soluble starch. This colors the treated portion a very dark blue, but does not affect the untreated wood.

Sodium fluoride is colorless and no satisfactory method of showing its presence in wood has been devised.

Mercuric chloride is shown by the blackening of the treated area when dipped in a solution of hydrogen sulphide.

Production of Domestic Graphite

There was a decrease of 88 per cent in the sales of domestic crystalline graphite in 1921 and a decrease of 61 per cent in the sales of amorphous graphite as compared with 1920. The following table shows the sales for the last 5 years:

DOMESTIC NATURAL GRAPHITE SOLD, 1917-1921

Year	Amorphous		Crystalline		Total	
	Quantity (Short Tons)	Value	Quantity (Short Tons)	Value	Quantity (Short Tons)	Value
1917.....	8,301	$73,481	5,292	$1,094,398	13,593	$1,167,879
1918.....	6,560	69,455	6,431	1,454,799	12,991	1,524,254
1919.....	3,379	47,716	4,043	731,141	7,422	778,857
1920.....	4,694	49,758	4,816	576,444	9,510	626,202
1921.....	1,842	20,860	595	75,664	2,437	96,524

The Packed Cell Process for Sulphuric Acid

Description of the Construction and Operation of the 25-Ton Unit at Anaconda, Mont.—Comparison of Efficiencies, Operating and Construction Costs Between This Plant and Modern Chamber Installations

By E. L. LARISON

THE packed cell sulphuric acid process developed at Anaconda, Mont., has shown some unusual results which should be of interest to the industry. This process has been developing in increasing sizes since 1917, up to the present plant with a capacity of 25 tons per day. This last installation involves all the apparatus and construction features which will be required in a plant of any size and has given data for the precise designing of all future installations.

This process is one which, like the chamber process, makes use of the reactions between sulphur dioxide, oxygen, water and the oxides of nitrogen. It produces acid of the usual grades made by a chamber plant—namely, 50 to 60 deg. Bé.

The chief points of interest in the process from the standpoint of practical operation are:

1. Cost of plant for a given tonnage is about 50 to 60 per cent of that of an equally well-built chamber plant.
2. Cost of operation is no more and under some conditions is less than that of a chamber plant.
3. Ground area used is only 30 to 40 per cent of that required for a chamber plant of equal capacity.
4. Process is established much more rapidly than is the chamber process, a valuable quality when plants have to stop and start frequently.
5. The maintenance cost is probably lower than that of a chamber plant, although this point cannot be definitely stated, since the existing plant is only 2 years old.

The packed cell plant consists essentially of a source of SO_2, a Glover tower, packed cells, Gay-Lussac towers, acid coolers, pumps and fans. The chemistry of this process is the same as that of the chamber process. It is to the physical and mechanical conditions created in the packed cells that the remarkable acceleration of the acid-producing reactions is due.

Physical Conditions in the Ordinary Chamber Plant

It is interesting to contemplate what may be called the niter processes in use today. We may consider as one extreme those chamber plants consisting of a small number of enormous chambers and as the other, the process under discussion. It is not intended to convey the impression that from an economic standpoint the large chamber plants are poorest, for that is not the case. They do, however, represent the antithesis in reaction speed of the packed cell process.

In those plants consisting of a few very large chambers, the mixture of SO_2, O, N, water and oxides of nitrogen, coming from the Glover tower, moves in a very slow, tranquil way through the chambers. Mixing or agitation and impingement of liquid particles on solid surfaces are slow and infrequent. Some such plants use over 20 cu.ft. of chamber space per pound of sulphur converted to acid per 24 hours. In these plants, too, the ratio of radiation surface of chamber walls and top to volume is low, and the heat of reaction is dissipated slowly, thereby further limiting their acid-making capacity.

In units consisting of a large number of small chambers the movement of the gas mixture is more rapid, mixing and impingement are caused by frequent passage from chamber to chamber, ratio of radiation surface to volume is higher and in some cases only 10 or 12 cu.ft. of chamber space per pound of sulphur per 24 hours is used.

Devices in Use for Cutting Down Chamber Space

We next observe the many schemes in which devices are used before, between and following the ordinary chambers for mixing the reacting gases, cooling them and providing wet surfaces for them to impinge upon. Among the better known of this class of process are the Gilchrist column, the process of N. P. Pratt, the Lunge plate tower and the ordinary packed "intermediate" tower. All these are effective and in some plants using them we find the total reaction space reduced to 7 or 8 cu.ft. per pound of sulphur. In general these processes aim chiefly at producing a more thorough mixing of the reacting gases.

A process which obtains faster reaction by means of high ratio of surface to volume and also by better cooling is that of Mills and Packard, so far used almost entirely in England. This process uses rather small lead chambers built in the form of frustums of cones, over the surfaces of which water is circulated. These plants have been operated using only about 4 cu.ft. of chamber space per pound of sulphur per 24 hours.

The rapid reaction attained in these chambers is probably due to unusual mixing, to the large amount of surface presented to the reacting gases and to the ability to use an unusually large proportion of nitrogen oxides in the gas mixture without raising the temperature of the chambers excessively.

Factors Influencing Reaction Velocity

A consideration of the facts briefly stated above, together with other phenomena of the niter processes, leads to these conclusions:

1. The velocity of the cycle of reactions between SO_2, O, water and the oxides of nitrogen, to form sulphuric acid, is greatly increased by vigorous mixing of the reacting gases.
2. The velocity of the cycle of reactions between SO_2, O, water and the oxides of nitrogen, to form

sulphuric acid, is increased by causing the gas mixture to impinge frequently upon wet surfaces.

3. The velocity of the cycle of reactions between SO_2, O, water and the oxides of nitrogen, to form sulphuric acid, is increased as the proportion of the oxides of nitrogen to the other components increases up to some proportion not yet indicated in commercial work.

4. In using proportions of nitrogen oxides appreciably greater than those used in well-managed chamber plants, it is necessary to provide means for controlling the temperature of the reacting gases more effective than simple radiation from the chamber surfaces to the surrounding atmosphere.

It was with these ideas in mind that the packed cell process was developed.

Details of the Packed Cell Plant

As the most effective practical means of causing vigorous mixing of the gases and at the same time providing a large amount of wet surface for cooling impingement and condensation, a column of acid-resisting brick was adopted. This is incased in lead or masonry and the reacting gases are driven through it by fans. The brick packing is so laid and the cross-sectional area is such that no unreasonable resistance to the passage of the required gas volume is offered. On account of structural considerations this packed column is built as a series of cells or towers.

It has been possible to design and build a plant entirely without lead chambers and consisting simply of a Glover tower, a set of packed cells and Gay-Lussac towers, to make acid at a rate corresponding to 1 cu.ft. of gross packed cell volume per pound of sulphur per 24 hours. When operating with a 7 to 8 per cent SO_2 gas, about 10 minutes is occupied in the passage of any given portion of gas from the entrance of the Glover to the exit stack. The plant which has been built and operated at Anaconda is shown in Figs. 1 to 7.

This plant operates on gas derived from roasting copper concentrate in a Wedge furnace. The gas is drawn from the furnace dust chamber through a 24-in. asbestos-covered steel flue, by a No. 11 Buffalo Forge "B" volume blower, provided with overhung runner, water-cooled bearings and a water-cooled gland where the shaft enters the case. The fan case is cast iron and the runner is of steel plate on a cast hub.

The fan forces the gas into the Glover tower, which is of standard design and dimensions. It is sheathed with lead and packed with Anaconda brick of standard dimensions. Two 4 x 4 x 4 ft. coolers receive and cool the outflowing acid. This division of the plant is just as would be provided for any chamber plant of equal capacity.

From the top of the Glover tower the gases pass

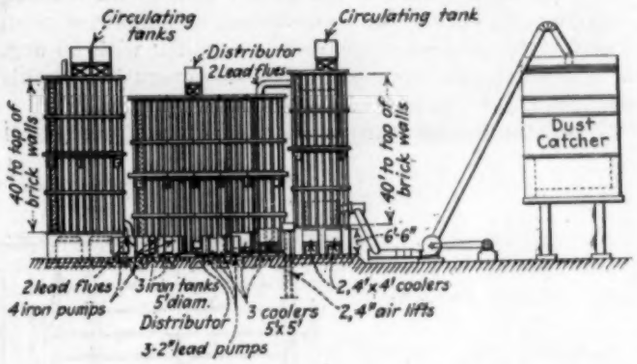


FIG. 2—ELEVATION OF 25-TON PACKED CELL PLANT AT ANACONDA

through a pair of flues to the packed cells. There are five of these packed cells built in one block and sheathed with lead. They are packed with acid-resisting brick of standard shape. The gas flow is down in No. 1, up in No. 2, down in No. 3, and so on. Experiment showed that there is no difference in efficiency whether the flow be up or down. Each cell is provided with its own acid-distribution system. The acid issues from the bottom of each cell into a launder and is conducted to the first of a set of three coolers in series. The cooled acid is pumped up to the distributing tank on top of the cells by a centrifugal pump. The gravity of the acid leaving the cells is maintained at such a point that it will take into solution neither SO_2 nor the oxides of nitrogen, that is 48 to 50 deg. Bé. This is accomplished by running water into the distributor boxes as needed. No water atomizers or steam are necessary. By varying the flows on the cells very close control of the gas temperatures can be maintained.

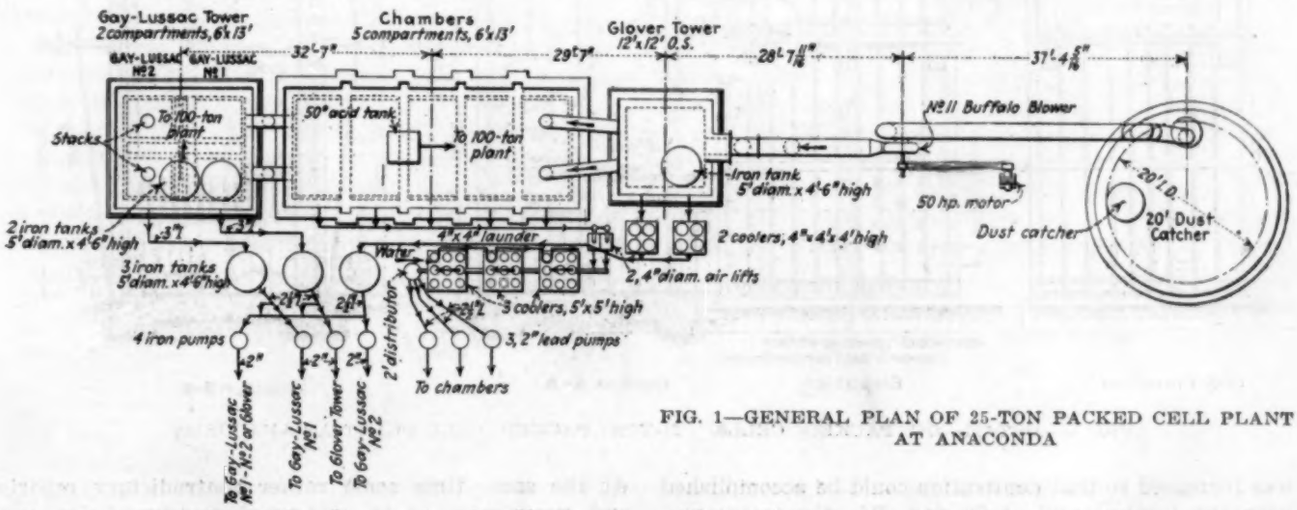


FIG. 1—GENERAL PLAN OF 25-TON PACKED CELL PLANT AT ANACONDA

Effect of Acid Concentration on Reaction Velocity

Some interesting data regarding reaction speed in towers using different acid concentrations were ob-

tained in the course of the experimental work. On account of conducting the burner gas a long distance, its temperature on entering the Glover tower was so low that it could not denitrate the nitrous vitriol fed, if the issuing acid was kept up to 60 deg. Bé. We ran for some time, therefore, with so large a quantity of 48 to 50 deg. Bé. acid and water going in with the nitrous vitriol that the issuing acid was only 50 deg. Bé. While this condition existed about 25 per cent of all the SO_2 entering the tower was converted to sulphuric acid. The Gay-Lussacs were meanwhile supplied with 60 deg. acid from the chamber plants. While operating in this way the plant was not, of course, an independent unit.

When the temperature of the gas entering the Glover with an interior downtake flue between them, so that the gas flow is upward in both. These towers have masonry walls and are sheathed with lead. They are packed with standard brick.

The acid throughout the plant is pumped by Lewis vertical submerged centrifugal pumps with direct-connected motors. The pumps for the tower acid, which runs 60 to 61 deg. Bé., are of iron, and those for the weak acid are of hard lead and lead-lined iron.

A consideration of the principles of this process discloses the feasibility of using masonry walls instead of lead for the packed cells. This follows from the fact that the circulation acid in the cells provides for cooling so that radiation from the walls can be neglected.

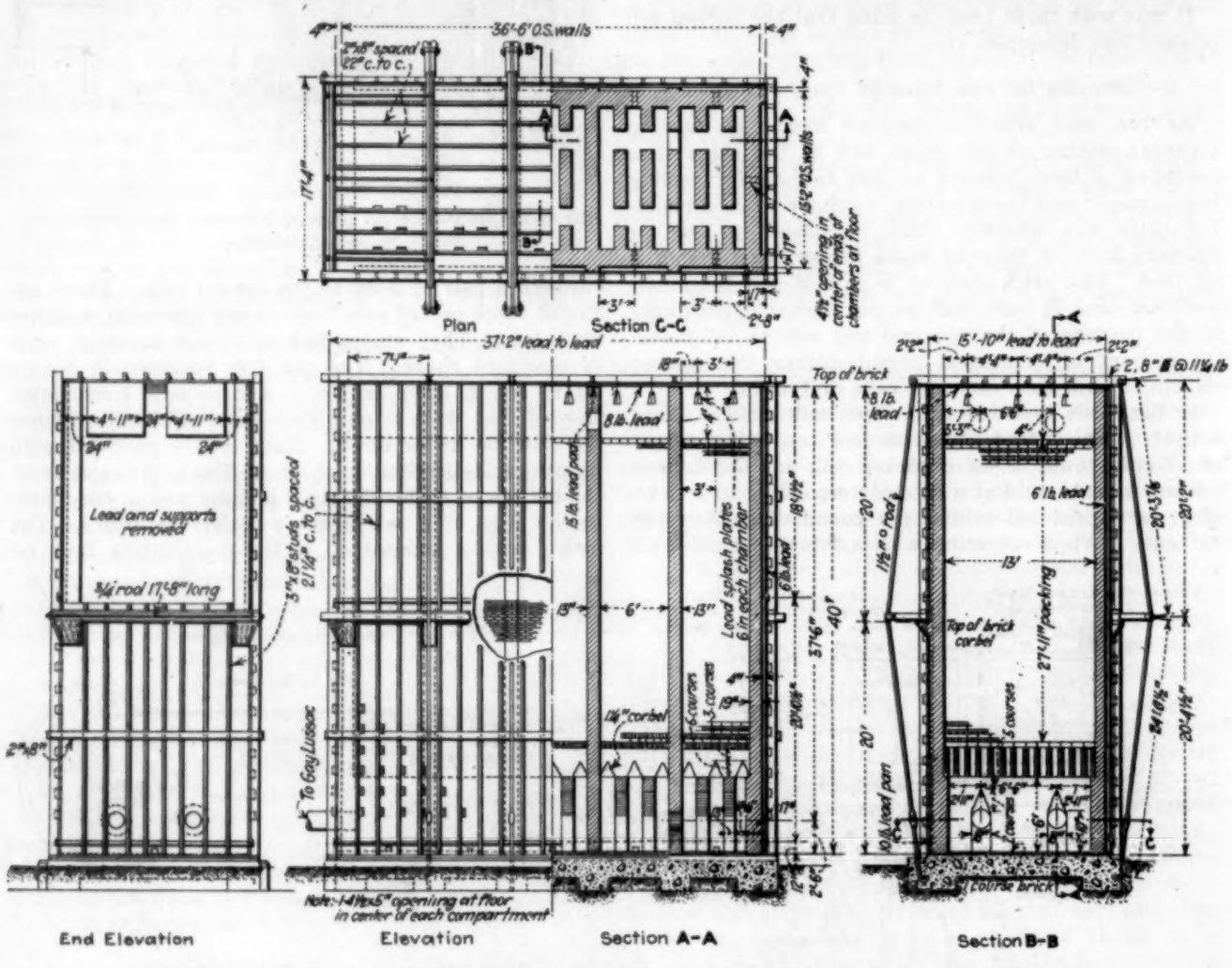


FIG. 3—DETAIL OF PACKED CELLS. 25-TON PACKED CELL PLANT AT ANACONDA

was increased so that denitration could be accomplished with the issuing acid at 60 deg. Bé., the water was cut off and the flow of weak acid reduced. In other words, the conditions became normal Glover tower conditions. Running in this way, the tower converted to H_2SO_4 only 10 to 15 per cent of the SO_2 entering. This is the way in which the tower must be operated for the plant to be self-sustaining.

The experience indicates that the reactions progress more rapidly when the acid present is around 50 deg. Bé. than when it is around 60 deg. Bé., which is another way of saying when the nitrogen compounds will not exist in solution, but only in the gaseous condition.

There are two Gay-Lussac towers built in one block At the same time some rather contradictory reports and experiences as to acid-proof masonry being gas tight led to the decision to build, in the case of this pilot plant, the cells and the Gay-Lussac towers with masonry walls and to sheath them with light lead, thus assuring a tight plant with which to work out the operating details. After the plant had been operated for several months and satisfactory results and data had been obtained, a part of the lead sheathing was removed from the packed cell block. It was found that the masonry wall alone was quite tight and entirely satisfactory. A consideration of this structural aspect will be taken up later.

This plant was built in the winter of 1918-1919, upon

the basis of data obtained from experiments upon a smaller scale. It was put into operation about May 1, 1919, and operated without interruption until Oct. 1, at which time a lack of demand for acid necessitated shutting down. In the spring of 1920 the plant was run for about 6 weeks, when inability to dispose of the product again caused a shut-down. Since that time, conditions have not been favorable to a resumption of operation.

The source of SO_2 from which acid is made at Anaconda is three Wedge furnaces roasting copper cencentrate. This concentrate carries about 8 per cent copper and ranges from 32 to 40 per cent sulphur. The gas produced is somewhat irregular and ranges from 7 to 8 per cent SO_2. This set of furnaces furnishes gas for two chamber plants and for the packed cell plant. The niter consumption in the chamber plants is 4 per cent on the sulphur in the acid produced. In view of the irregularity of the gas and the fact that Anaconda is 5,300 ft. above sea level with a normal barometric pressure of 622 mm., a 4 per cent niter loss is not abnormal.

It is, in fact, comparable with 3 per cent niter loss in a plant burning brimstone and at a lower elevation. In considering the performance of the packed cell plant these conditions must be borne in mind and comparison in the matter of niter loss and production made with the chamber plants operating under the same conditions and not with a plant burning brimstone at sea level.

Performance of the Packed Cell Plant

The average daily production of the packed cell plant over a period of a little over 6 months was 20.3 tons of 60 deg. Bé. or 25.5 tons of 50 deg. Bé. acid. Direct figures on the yield in terms of acid produced per ton of sulphur burned could not be obtained because of the fact that all three plants were taking gas from the same battery of roasting furnaces. Very close control on the amount of SO_2 in the gas going to the Gay-Lussac towers was maintained, however, so that the yield was necessarily very high. The consistently low exit test is shown in the operating log, Table I.

The average daily niter consumption during the same period was 670 lb. of $NaNO_3$, or 6.6 per cent, figured on the sulphur in the acid produced. During the early part of the operation the niter consumption was around 8 per cent. This was consistently reduced as the operators became accustomed to the plant, and practice was improved so that during the last weeks of the run the niter loss was running about 4.4 to 4.5 per cent on the sulphur.

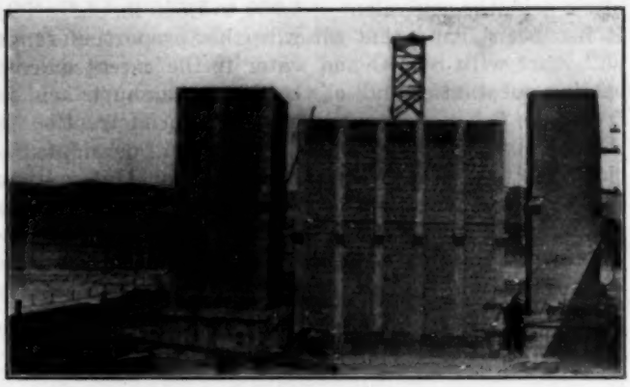


FIG. 4—25-TON PACKED CELL PLANT AT ANACONDA DURING CONSTRUCTION

Extensive tests were made to determine the character of the niter loss. These showed that about 55 per cent of the total niter in the stack gases could be absorbed by further contact with 60 deg. Bé. acid. It is quite certain, therefore, that by providing additional Gay-Lussac space, the niter loss in this process will be no more than that in a chamber plant operating under parallel conditions.

Comparison of Niter Rate in Chamber and Packed Cell Plants

A brief analysis of the niter recovery and loss figures of the packed cell process in comparison with the chamber process is in order. It has been mentioned that the unusual speed of reaction attained in the former is largely due to its ability to use higher than the ordinary proportions of the oxides of nitrogen.

In the usual chamber process the total amount of niter (nitrous vitriol plus fresh niter) introduced into the Glover tower, expressed in terms of $NaNO_3$, is 20 to 30 per cent of the amount of sulphur introduced in the same time. For example, if a plant makes 50 tons of 60 deg. acid in 24 hours, approximately 12.5 tons of sulphur as SO_2 is put in and there will be introduced as nitrous vitriol plus the gases from the pots, or fresh

TABLE I—SEVEN DAY LOG OF ANACONDA 25-TON PACKED CELL PLANT

	April 12	April 13	April 14	April 15	April 16	April 17	April 18
Tons 60 deg. Bé. produced	19.7	21.09	19.64	21.03	19.6	22.51	24.0
Lb. 96 per cent $NaNO_3$ used	516	388	387	513	424	400	465
Per cent $NaNO_3$ on 8 basis	5.2	3.7	3.9	4.9	4.3	3.5	3.9
Per cent SO_2 entering cell 1							
Shift 1	7.3	7.1	7.0	7.1	6.8	6.3	6.7
Shift 2	7.1	6.7	6.5	6.7	6.7	5.8	6.1
Shift 3	6.6	6.6	6.3	6.7	6.1	6.4	5.6
Per cent SO_2 entering cell 5							
Shift 1	0.025	0.015	0.01	0.015	0.022	0.027	0.01
Shift 2	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Shift 3	0.01	0.01	0.008	0.009	0.009	0.011	0.011
Oz. $NaNO_3$ per cu.ft. in acid from Gay Lussac No. 1	1.79	81	77	77	74	68	70
Oz. $NaNO_3$ per cu.ft. in acid from Gay-Lussac No. 2	2.33	33	30	27	26	21	20
Temperature gas entering Glover, deg. F	531	539	561	546	524	550	574
Temperature gas entering cell No. 1, deg. F	172	170	169	174	166	167	171
Temperature gas entering cell No. 3, deg. F	166	163	161	159	159	162	164
Temperature gas entering cell No. 5, deg. F	118	121	120	125	123	115	124
Temperature gas entering Gay-Lussac No. 1, deg. F	86	89	90	93	94	93	94
Deg. Bé. acid from Glover	60.6	60.2	60.1	60.0	60.1	60.1	60.1
Deg. Bé. acid from cells	48.5	48.5	48.5	48.6	48.6	48.6	48.3
Temperature acid to cell cooler No. 1, deg. F	134	137	138	132	125	134	139
Temperature acid from cell cooler No. 1, deg. F	94	91	91	90	89	90	94
Temperature acid from cell cooler No. 2, deg. F	74	72	72	71	71	72	73
Temperature acid from cell cooler No. 3, deg. F	62	61	62	60	60	62	61
Pressure difference cell No. 1 to exit stack, inches water	0.30	0.34	0.38	0.35	0.39	0.35	0.41

SO_2 entering cell No. 1 determined by caustic absorption in Orsat.
SO_2 entering cell No. 5 determined by Reich test using N/500 iodine with acetate mixture.
Nitrosity of Gay-Lussac acids determined by titration with permanganate solution.
Pressure difference determined with Ellison differential draft gage.
SO_2 figures represent averages of tests made every 30 minutes. All other tests made hourly.
SO_2 in gas entering Glover is about 15 per cent higher than in gas entering Cell No. 1. Tests were made at latter point because the location was more convenient.

nitric acid, the equivalent of 5,000 to 7,500 lb. of $NaNO_3$. It has been found that niter in this proportion range will react with SO_2, O and water to the extent of converting substantially all of the SO_2 to sulphuric acid in from 1 to 2 hours, depending upon the construction of the chamber set. Such a gas mixture will develop sufficient reaction heat, with the sensible heat already in it from the burners, to produce in the front chambers temperatures approaching 100 deg. C.

If we attempt to make this set of chambers produce 100 tons of acid instead of 50 tons, it will be necessary to put through it twice as much SO_2 as before—i.e.,

FIG. 5—SIDE VIEW OF 25-TON PACKED CELL PLANT AT ANACONDA

assuming the same volume per cent of SO_2 in the gas, a given portion of gas will pass through the chambers in one-half the time it took when the plant was making 50 tons. In order to convert completely the SO_2 to H_2SO_4 in this reduced time, it will be necessary to substantially double the proportion of the nitrogen oxides, or to introduce in a given time four times as much as when the plant was making 50 tons per day. If this were done, we would find that due to the limited radiating capacity of the chambers the temperatures in the leading chambers would be too high for the proper reaction cycle and the process would work badly, with low yield and excessive niter loss.

In the packed cell process the ratio of sulphur to total nitrogen oxides introduced, in terms of $NaNO_3$, is about 10 to 7. In other words, where the chamber plant can rarely handle niter to the extent of more than 30 per cent of the sulphur, the packed cell plant can readily use 70 per cent, the reason being, as mentioned, the control of temperature afforded.

It should be clearly understood that the above figures do not mean new niter introduced—i.e., niter loss—but total niter, including nitrous vitriol.

In the chamber process operating at Anaconda under the same conditions, the total niter circulation is about 25 per cent on the sulphur and the niter loss is about 4 per cent. In the 50-ton chamber plant, for example, the sulphur input is about 25,000 lb., the total niter introduced about 6,250 lb. and the niter loss about 1,000 lb. per 24 hours. The loss, therefore, is 16 per cent and the recovery 84 per cent.

It will be readily seen that in a process using 70 per cent niter circulation instead of the customary 20 to 30 per cent, a much higher percentage recovery is necessary. If, for example, in a 50-ton-per-day plant we introduce the equivalent of 17,500 lb. of $NaNO_3$, which is 70 per cent of 25,000 lb., and wish to sustain a loss of only 1,000 lb., we must make a Gay-Lussac recovery of 94 per cent.

It is customary in chamber plants to provide from 125 to 175 cu.ft. of gross packed Gay-Lussac volume per ton of 60 deg. acid made. This amount gives ordinarily about the 84 per cent recovery mentioned. In the 25-ton packed cell plant under discussion the Gay-Lussac space provided is 213 cu.ft. of gross packed volume per ton of 60 deg. acid made. Total niter introduced amounted to about 7,000 lb. per 24 hours. Using the average loss figure of 670 lb., the recovery was 90 per cent. During the latter part of the operation, when the loss was about 460 lb., the recovery was about 93 per cent.

Niter was introduced into this plant in the form of mixed nitric and sulphuric acid, the production of which was described in a previous article.[1]

The question naturally arises why is it not possible in this type of plant to increase still further the niter circulation, decrease the volume of the packed cells and increase the Gay-Lussac space to get the additional niter recovery necessary. Perhaps this can be done to a limited extent. However, acid makers generally agree that there will inevitably be some niter going out the stack which is not soluble in sulphuric acid. Whether this be nitrogen compounds in a state of oxidation below NO or what not, it seems that between 3 and 5 per cent of the total nitrogen oxides introduced is not recoverable in Gay-Lussac towers. Somewhere, then, not far above the proportion carried in the present operation, an economic balance arises in the matter of niter ciculation beyond which it is not well to go.

Suppose, for example, a 95 per cent recovery of total niter introduced is all that we can recover even with

[1] "Introduction of Niter Into Sulphuric Acid Processes as Mixed Acid," by E. L. Larison, CHEM. & MET. ENG., vol. 26, No. 14, April 5, 1922, p. 642.

FIG. 6—END VIEW OF 25-TON PACKED CELL PLANT AT ANACONDA

greatly increased Gay-Lussac space. Assume that a niter circulation double that mentioned, or 140 parts of $NaNO_3$ per 100 parts of sulphur, be used. If 5 per cent of the niter be lost, the niter rate as $NaNO_3$ on the basis of sulphur will be 7 per cent.

A plant to operate with such niter proportions would need less cell space and more Gay-Lussac space than one using the 70 to 100 proportion and its cost would be almost the same. It is obvious, therefore, that the economic limit of niter circulation lies near that used in the present operation.

Power

The power used is all electrical, no steam or air being required. For pumping acid to the Gay-Lussac and Glover towers three centrifugal pumps were run continuously. The amount of acid fed to each tower was about 75 tons per 24 hours, so the total amount pumped was about 225 tons. These pumps are equipped with 5-hp. motors. The full capacity of these pumps is about 250 tons per day, so they were less than one-third loaded.

The acid for the cells was circulated by one centrifugal pump running continuously. The amount of acid fed to the cells was 250 to 275 tons per day. This pump is equipped with a 5-hp. motor and was pumping to full capacity.

The motor driving the draft fan used 20 hp.

Water

Water used for cooling the acid amounted to 50,000 to 60,000 gal. per 24 hours. It was not necessary at Anaconda to re-use the cooling water, but in case such procedure were necessary it would present no difficulties.

Labor and Maintenance

The plant was operated by one operator with one helper per shift. The operator made hourly observations and records of the SO_2 percentages of the gas entering the first and fifth cells, the nitrosity of the Gay-Lussac acids, the gravity of the Glover and cell acids and the draft gages. Operation of the pumps was entirely automatic. The helper had very little to do.

On account of the very compact nature of the plant and the fact that there are no actual operations to be performed (assuming that SO_2 is available as a by-product of the smelter) but simply regulation of acid and gas flows, a plant of any size can be operated by two men per shift.

The plant has not been operated long enough to require repairs of any consequence. The centrifugal pumps are very satisfactory. One pump of this type has been in use in one of the chamber plants for 3 years without any repairs whatever. So far as the operation has gone it seems reasonable to expect the general repair and maintenance costs to be smaller than those of a chamber plant.

Comparison of Costs

A general consideration of operating and repair cost figures on chamber plants and the packed cell plant at Anaconda leads to the conclusion that with plants of the same tonnage capacity the costs mentioned over a period of years will be at least equal for the two types of plant and probably lower for the packed cell type. In the matter of interest and depreciation charges the packed cell plant shows a very great advantage, since its first cost is so much less than that of a chamber plant.

The 25-ton pilot plant at Anaconda described and illustrated herein cost $68,066. It has been mentioned that the cells and the Gay-Lussac towers were built with both masonry and lead walls in order to assure a tight plant. The cost of the lead sheathing and its supporting framework on these two structures was $14,000. The cost of the plant without this precautionary sheathing was $54,000.

It is only fair also to say that at the time this plant was constructed, 1918-1919, material and labor prices were at a very high point. Some unit costs of the chief items of this construction were as follows:

Leadwork in place, per ton	$305
Brick in place in mortar, per thousand	52
Brick in place, dry, per thousand	27
Concrete in place, per cubic yard	17
Woodwork in place, per thousand	167

A considerable part of the lumber used was Douglas fir, which cost at the time $75 per thousand feet.

The experience gained in the construction and operation of this plant has made it clear that the cell and Gay-Lussac portions of future plants may be built with either the conventional lead shells and without masonry interior walls, or with masonry walls unsheathed. This latter construction has been demonstrated to be entirely satisfactory here in the Anaconda plant and at many other places as well. In designing future plants, therefore, it is necessary to ascertain the respective costs of the two kinds of construction and to use that one which is least expensive. The relative costs will depend largely upon the market price of lead, the freight haul and the cost of suitable brick- and mortar-making materials.

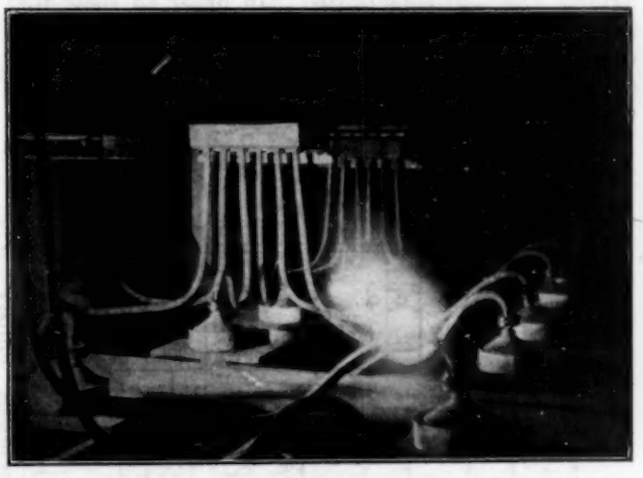


FIG. 7—ACID DISTRIBUTORS ON CELLS

At Anaconda the masonry construction is decidedly less expensive because bricks cost only $10 to $12 per thousand, and excellent ground silica costs about $3.50 per ton. Moreover, lead and steel are comparatively expensive because of the long freight haul. It may be said in general that when sheet lead and pipe can be laid down at the plant for 7c. and standard acid-proof brick for $25 to $30 per thousand, the cost of the two kinds of construction will be about equal.

Acid-Proof Brick Used at Anaconda

Some discussion of the brick suitable for this work is pertinent. For the past 5 or 6 years brick made from slime tailings produced in the concentration of the Butte ores have been used at Anaconda for tower walls and packing in the sulphuric acid plants here. This brick is entirely satisfactory for the purpose. The analysis of

the material is as follows: Silica, 74 per cent; iron, 1.6 per cent; lime, 1.1 per cent; alumina, 19.1 per cent; magnesia, 1.3 per cent.

The method of manufacture is simple. The slime is delivered to the brick plant containing varying amounts of moisture up to 22 per cent. It is fed into a rotary drier with a small percentage of sand, and the mixture is dried to about 15 per cent moisture. After being discharged from the drier the material passes through a set of conical rolls and thence into a pug mill. This machine, into which usually a little water is fed, thoroughly mixes the mass and delivers a homogeneous stiff mud. This mud is fed to an auger machine, which makes plain wire cut brick. After passing through a tunnel drier the brick are burned in an Oregon continuous kiln. No attempt is made to vitrify, and while the brick are hard and have a good ring there is no suggestion of a glaze.

Variations in Analysis of Satisfactory Brick

This Anaconda slime is, of course, of an excellent natural chemical composition. In order to show that considerable variations in analysis may exist between different grades of brick satisfactory for acid plant construction, analyses of two other bricks used in plants under the writer's observation are given herewith.

No. 1. A brick manufactured by an Eastern factory especially for acid work analyzes: Silica, 62.8 per cent; iron, 6.9 per cent; lime, 1 per cent; alumina, 23.7 per cent; magnesia, 1 per cent.

No. 2. A paving brick made on the Pacific coast analyzes: Silica, 64.8 per cent; iron, 4.6 per cent; lime, 3 per cent; alumina, 26.2 per cent; magnesia, 1.2 per cent.

With these analyses and several others in view, showing considerable ranges in the silica, iron, lime and alumina percentages, it seems fairly evident that in almost any locality satisfactory acid-resisting brick can be obtained at reasonable prices. It should not be assumed that any brick will do, because some brick, for chemical or mechanical reasons, disintegrated badly. Usually tests on crushing strength, weathering after saturation with acid, chemical analysis and general physical characteristics tell the acid engineer whether the brick is proper for the work.

The mortar used for laying acid-resisting masonry at Anaconda is made by mixing 30 deg. Bé. silicate of soda solution with finely ground Dillon rock, which is an almost pure natural silica. This mortar sets slowly, as the hardening is simply due to evaporation. It should be permitted to stand several weeks in an atmosphere as warm and dry as possible, in order that it may become thoroughly hard. After this set has taken place the masonry is sprayed or washed with sulphuric acid, which reacts with the silicate of soda to form silica and sulphate of soda. The mortar mass after this treatment consists of about 85 to 90 per cent of SiO_2 and 10 to 15 per cent $NaSO_4$ and water. In this condition it is practically unaffected by acid or water.

During the period of laying and hardening and up to the treatment with acid, acid-resisting masonry should be protected from rain or snow and kept as warm and dry as possible. This often means that during the construction of a packed cell plant of the masonry type a temporary shed must be constructed. In some cases when the climate and season are favorable only tarpaulin covers are required. In the case of the lead shell construction no such protection is necessary at any time.

Packed cell plants have been designed in 10, 25, 50, 100 and 250 ton capacities. In

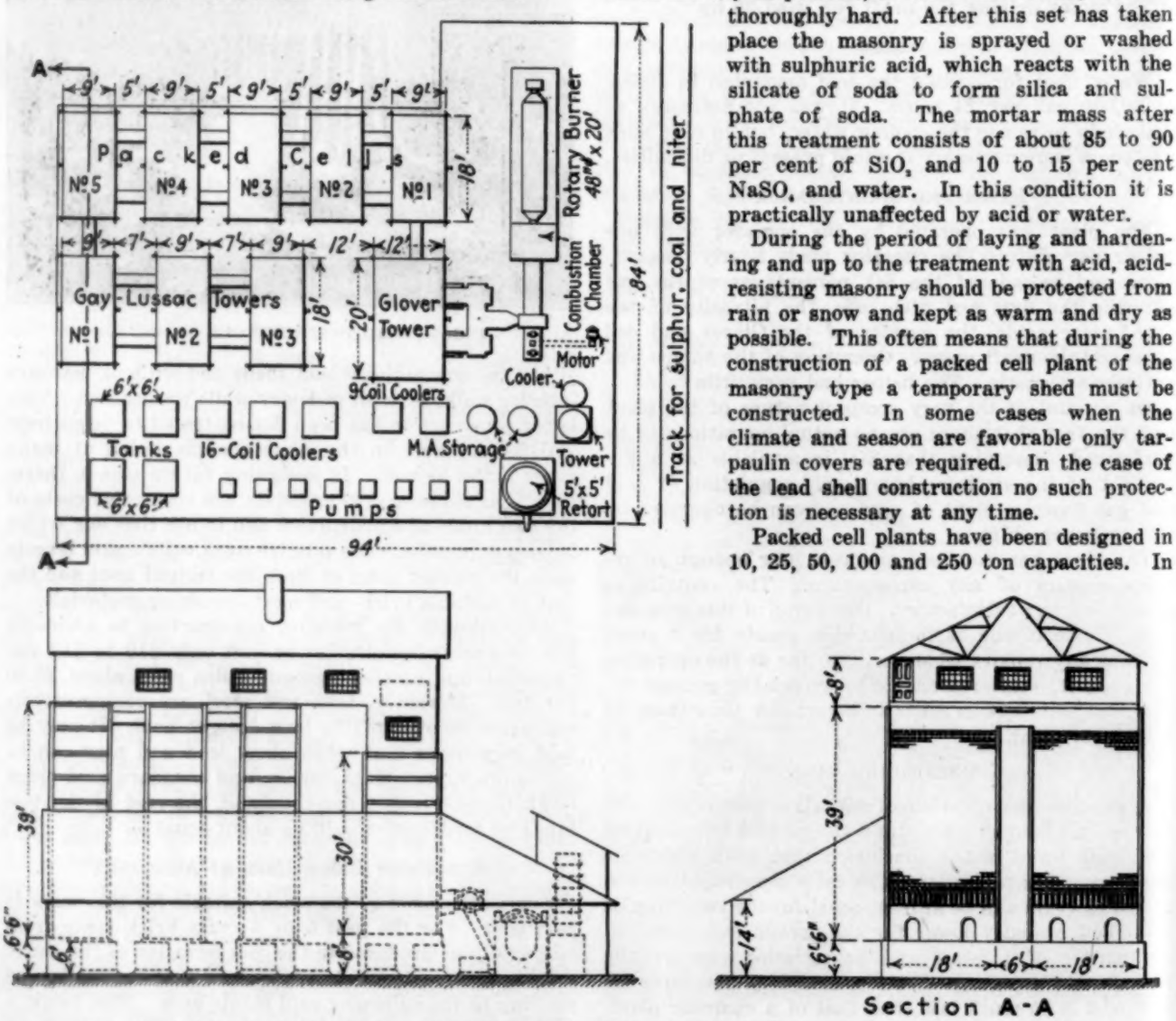


FIG. 8—GENERAL LAYOUT OF A COMPLETE 50-TON PACKED CELL UNIT OF THE LEAD SHELL TYPE

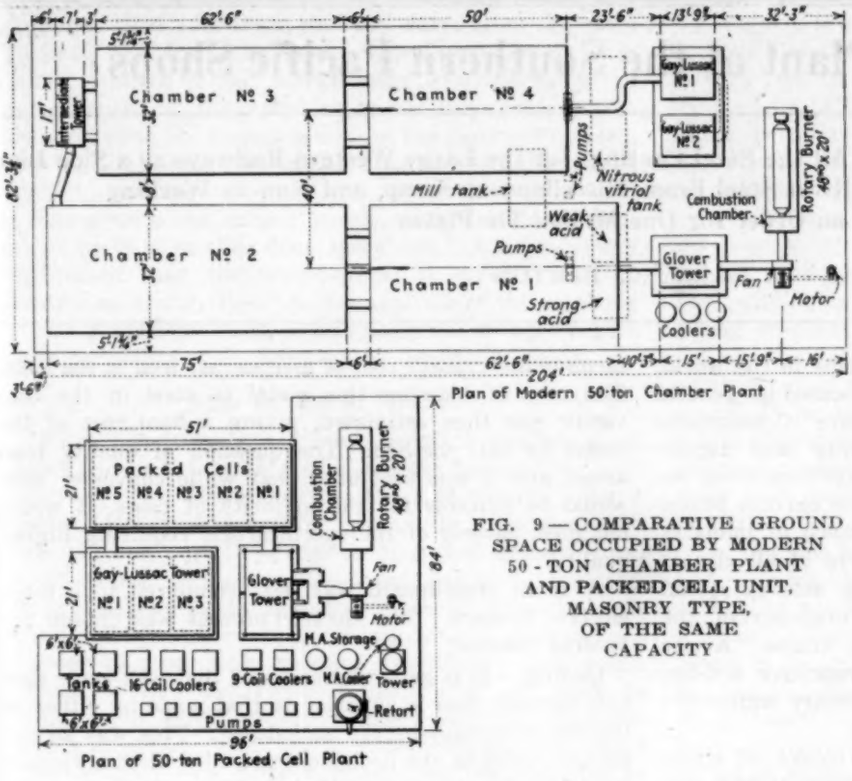


FIG. 9 — COMPARATIVE GROUND SPACE OCCUPIED BY MODERN 50-TON CHAMBER PLANT AND PACKED CELL UNIT, MASONRY TYPE, OF THE SAME CAPACITY

order to show the principal features of the plants as now designed Figs. 8 and 9 are shown of a 50-ton 60 deg. acid per day packed cell plant of brick construction and another of lead shell construction.

In Table II are given the relative costs of the two kinds of construction and the quantities of materials required for each.

Fig. 10 shows the relative ground space occupied by the packed cell plant of 50-tons-per-day capacity, and a modern chamber plant of the same capacity.

Comparative Costs of the Two Types of Packed Cell Construction

The chief advantage offered by the packed cell process is its low first cost. For example, a 50-ton 60 deg. Bé. acid per day plant can be built at present for something between $110,000 and $120,000, depending on local conditions. The cost of a chamber plant of this same capacity built in 1921 by one of the leading engineers in this country was approximately $220,000. This is a brimstone plant and the expenditure included the cost of the burner equipment. Another modern chamber plant completed in the early part of 1921 cost about $180,000 and has a rated capacity of 40 tons per day, which is in almost the same proportion.

If a chamber plant costs $220,000, produces 16,500 tons of acid per year, and is amortized at 12 years, the charge against the acid is $1.11 per ton. If the packed cell plant costs $120,000, produces 16,500 tons per year and is amortized at 12 years, the charge against the acid is $0.58 per ton.

With sulphur at $16 per ton, the cost of acid, including the amortization charge, is not far from $8.50 per ton of 60 deg. acid for the chamber plant of average size. For the packed cell plant this cost is about $8.

If the acid from each plant be disposed of to yield $10 per ton, the annual profit from the chamber plant on 16,500 tons is $24,750, which is 11.2 per cent on the $220,000 invested. The profit from the packed cell plant is $33,000 per annum, which is 27.5 per cent on the $120,000 invested.

This process is covered by Patent Specification 1,342,024.

TABLE II—COST ESTIMATES FOR 50-TON PACKED CELL PLANTS

	—Lead Sheathed—		— Masonry —	
	Amount Required	Cost	Amount Required	Cost
Excavation	.....	1,000	.....	1,000
Concrete @ $15	462 yd.	6,930	489 yd.	7,335
Brick in mortar @ $60	121 M.	7,260	346 M.	20,760
Brick dry @ $35	507 M.	17,745	507 M.	17,745
Lead in place @ $250	160 tons	40,000	85 tons	21,250
Steel erected @ $125	36 tons	4,500	12 tons	1,500
Woodwork @ $100	75 M.	7,500	75 M.	7,500
Roofing @ $25	160 sq.	4,000	160 sq.	4,000
Doors and windows	.....	1,200	.....	1,200
Pumps, 8 @ $500	.....	4,000	.....	4,000
Fans and flues	.....	2,000	.....	2,000
Lead valves	.....	775	.....	775
Painting	.....	1,100	.....	1,000
Electric wiring	.....	1,200	.....	1,200
Sulphur burner	.....	4,000	.....	4,000
Nitric plant	.....	3,900	.....	3,900
Water piping, sewers and miscellaneous, $5,000 to	.....	10,000	.....	10,000
		$117,110		$109,165
Temporary protection shed	.....	.....	.....	5,000
Total	.....	$117,110	.....	$114,165

The Mica Industry in 1921

The mica industry in 1921 on the whole reflected the general depression of business all over the country, according to a preliminary report issued by the United States Geological Survey. The decrease in the domestic output, sales and prices is marked and is not balanced by an increase in the imports. Several mica companies, especially in the South, were idle the entire year, and one large company discontinued business entirely.

Preliminary figures showing the quantity and value of mica sold in the United States in 1921 give a total of 3,854 short tons, valued at $174,838. Of this quantity 371 tons (741,190 lb.), valued at $117,989, was sheet mica; the rest was scrap mica. These figures are obtained from reports received by the Geological Survey from 97 per cent of the producers and others engaged in the mica business.

The production was made by eight states—North Carolina, New Hampshire, Virginia, New Mexico, Georgia, South Dakota, Colorado and Wisconsin, named in order of total value of mica sold from greatest to least.

The total quantity of uncut sheet mica sold in 1921 shows a decrease of about 56 per cent, and the value a decrease of about 78 per cent; scrap mica showed decreases of about 39 per cent in quantity and of about 66 per cent in value, as compared with 1920. Comparisons cannot strictly be made with any year previous to 1920, as the figures for those years include cut mica, or mica that has been through several stages of preparation for the market and thereby commands a higher price than uncut mica.

The average price per pound of all sheet mica sold in the United States in 1921 was 16 cents, as compared with 32 cents in 1920, and the average value per ton of scrap mica fell from $29 in 1920 to $16 in 1921.

Electric Steel Plant at the Southern Pacific Shops

Six-Ton Heroult Furnace Produces All the Steel Castings for the Large Western Railways as a Side Line —For a Year It Produced Rivet Steel From Miscellaneous Scrap, and Now Is Working on an Order for One Million Tie Plates

BY LARRY J. BARTON

ONE of the largest railroad systems in the world, the Southern Pacific company, located its general shops at Sacramento, Cal., where it maintains large and well-equipped manufacturing and repair facilities. These shops have been in existence since the late '80s, gradually expanding to handle current needs. They now include practically every branch of industry necessary for the complete manufacture of all classes of locomotives and cars, besides being able to attend to the necessary repairs for other branches of the service such as steamboats and electric trains. A late acquisition is a steel-making shop, comprising a 6-ton Heroult electric furnace, with the necessary equipment for the making of ingots and castings.

Previously it has been the practice to collect old scrap, pile it carefully in bundles, wire the bundles tightly and send it to a small merchant mill owned by the railway company. Here these bundles were put into an oil-heated furnace, and when up to a good welding heat, were put under a steam hammer and worked down into compact billets. These were then reheated and rolled into the finished product. All sizes of small iron bars were made, together with flats up to 6 in. in width and 1½ in. thick. However, the steel pieces would never form a solid billet, due to the layers of oxide surrounding each piece; the method resulted in a large waste of split unsound bars and a product suitable only for low-grade work. Such work could scarcely be called steel manufacturing, and all steel for rivets, forgings or important members had to be purchased on the open market.

There were many ways in which a steel mill would be advantageous to the company shops, situated as they were, far from a large producer. Every year the road scraps large tonnages of wrought iron and steel of which only a small part was used in "fagoting," the remainder being sold on the market at whatever price could be obtained. Eventually this fell into the hands of different commercial steel companies, which remelted it and often resold it to the railroad company in the form of desired products, one of the highest priced being steel castings. It seemed reasonable on the face of this to suppose that if a small steel company buying scrap could furnish certain products at a given price, a resourceful plant using its own scrap could furnish the same product at an equal price or even cheaper, figuring the handling of the scrap as a saving.

With the proposal to build a steel plant accepted, there yet remained the question as to what sort of a melting furnace to install. Cupolas and converters, open-hearth furnaces and the electric furnace were very carefully considered from all angles.

For many years the company had been running its own iron foundry, and it was an easy matter to determine the average cost of molten cast iron in the ladle. The cost of blowing this metal to steel in the converter was then estimated, giving a final cost of the metal by this method. The question of quality then arose, and it was concluded that while converter steel would be suitable for the majority of cases, it would not meet several of the specifications requiring higher quality.

A small open-hearth was next compared to a 6-ton electric furnace. The electric process was chosen for several reasons:

Quality.—It is generally accepted that well-made electric furnace steel is superior to that made by either of the two processes before considered. This was an important point in the decision, especially when anticipating high class forging work for such products as gears, driving rods, crank pins, shafts and small axles, where a failure would tie up a locomotive and cost several hundred dollars per day in delays.

Cost.—Cost of the finished steel was, of course, the main deciding factor and was given the greatest consideration. It was figured not only for present conditions but for reasonably anticipated developments on the Pacific Coast in the near future. When this matter had been finally computed, it was found that the difference in the costs of the three proposed methods were very small, but a slight advantage was shown in favor of the electric furnace. High freight cost of Eastern pig iron militated against the converter. Inability to obtain "hot metal" for the open-hearth furnace militated against this process. There is no blast-furnace coke manufactured on the coast; furthermore, on account of the refractory nature of California iron ores, the erection of a blast furnace in this region is a very distant possibility. The present cost of electric power is rather low in comparison to the rest of the United States; this is likely to continue, since further great developments are under construction. That these factors were well weighted has been amply proved, since the electric furnace installed has turned out the highest grade of steel at a lower cost than it could be procured from several competing open-hearth plants, and has even melted gray iron for castings cheaper than the cupola.

Adaptability.—This point was so much in favor of the electric furnace that it scarcely needs discussion. Suffice it to say that the same furnace, without change of any kind, can economically make the following: steel castings; manganese steel castings; any required analysis of alloy and carbon steel for rolling or forging; iron castings, gray, chilled or white, of any analysis desired; malleable cast iron castings; special products such as acid-, fire-, and fume-resisting castings; special steels for magnets, electrical apparatus and trans-

formers. Not only these products came from the same furnace, but from the same general scrap, with only minor changes in the charge ratio. Furthermore, the temperature of the metal is under easy control (depending upon the time it is held in the electric furnace), making the furnace an excellent melter for either small, medium or large sized castings.

These were the salient points. An electric furnace plant needs a smaller floor space and lighter accessory equipment than the open-hearth; it is very easy to control accurately the chemical analysis of the resulting steel. An electric furnace also possesses an unexampled refining ability when working on low-grade scrap.

Acid vs. Basic Process

When the furnace had been installed another point arose as to whether we should use the basic or the acid process. The advantages for the acid process were a hotter steel, with a greater tonnage in a given period. Against this were the disadvantages that selected scrap must be used to meet specifications, due to the inability of acid bottom to eliminate any material amount of sulphur and phosphorus; specifications and analyses are harder to meet with constant exactitude; alloy steels cannot be very satisfactorily made, and can never be remelted to save high-priced alloys such as chromium and manganese; and finally power surges give more trouble than in a basic furnace. As the scrap to be used was high in phosphorus and sulphur, due to large quantities of wrought iron mixed in it, it was really imperative to use the basic process. Against the disadvantage of higher cost for this process were the ability to make any analysis with ease; great refining possibilities; easier power control; elimination of power surges and high peak loads; reclamation of alloy steel scrap; and most important of all for quality stock, complete de-gasification of the hot metal.

The furnace is located in an ordinary wooden frame building 130 ft. long by 65 ft. crane span, with a 30-ft. side bay on each side. The building, which was constructed in 1919, is higher than most steel foundries, which permits a ready exit of smoke and gas and makes excellent working conditions. This height was necessitated by building the furnace on a 10-ft. concrete platform in order to protect the ladle pit from any seepage of water, the shop being built on filled-in ground, once a marsh adjacent to the Sacramento River. The building is of the latest glass-walled construction, giving excellent light for molding purposes.

From the floor plan (Fig. 1) a very good idea can be obtained as to the general layout. The center bay is served by a 15-ton Champion crane. The shop was put in operation early 1920, and several improvements are now needed, such as another crane, a stripper and more floor room, all of which are expected to be made in 1922.

On the side floors are the bench molding, coremaking and cleaning departments, together with all like miscellaneous equipment. Directly in front of the furnace are the ingot pits. All ingots are plate poured (Fig. 2). Scrap is brought into the foundry on a standard gage flat car in large round buckets, containing about 2,500 lb. of such metal as old track scrap, forge butts, borings and turnings, forge flashings and clippings, all of which furnishes good material for the desired products. The furnace is charged by hand.

Operation of the furnace follows the standard two-slag process: eliminating phosphorus in the first, and finishing under a heavy carbide slag. The furnace is operated continuously and the results for the first 2 years have averaged 565 kw.-hr. per ton of charge, 33 minutes per ton of charge with the ordinary charge 7 to 8 tons in the ladle. Electrode consumption has averaged 30 lb. on carbon electrodes and 12 on graphite

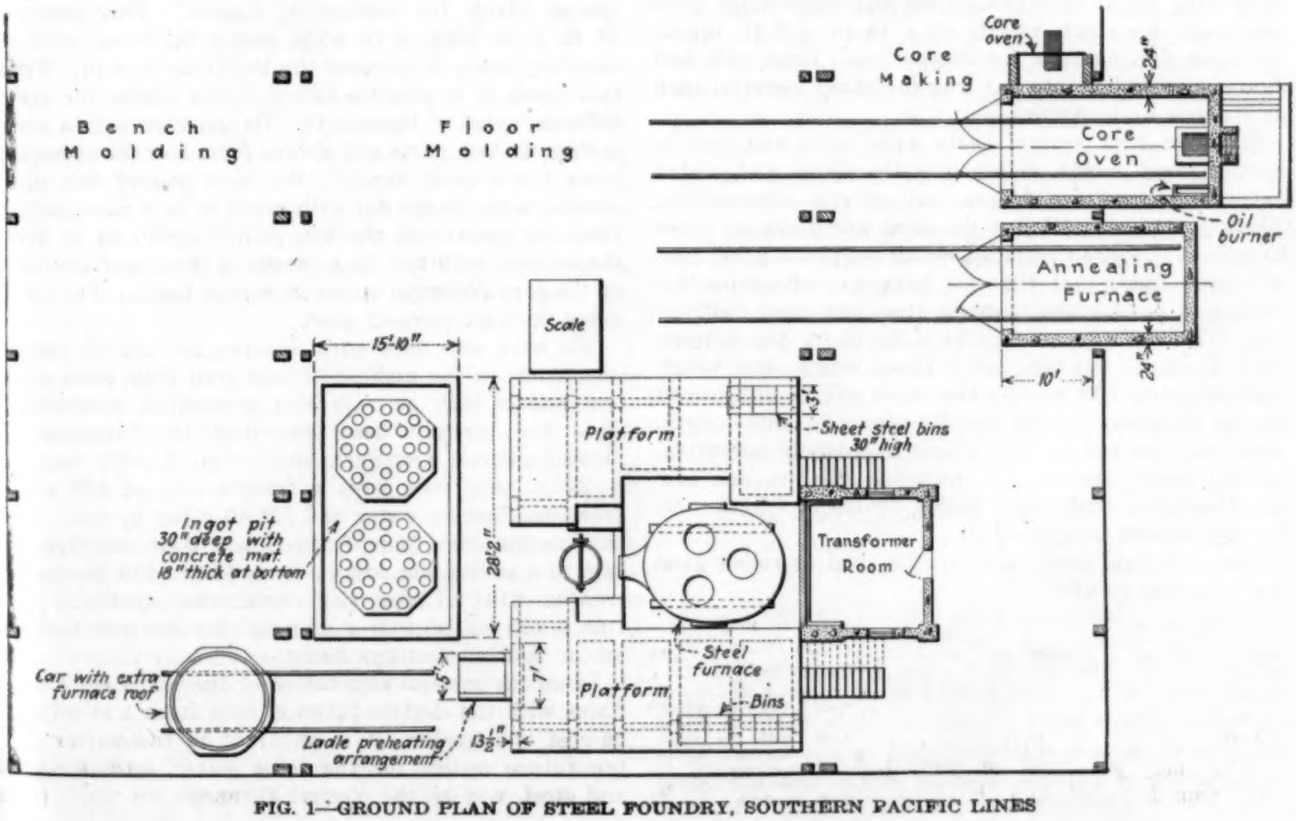


FIG. 1—GROUND PLAN OF STEEL FOUNDRY, SOUTHERN PACIFIC LINES

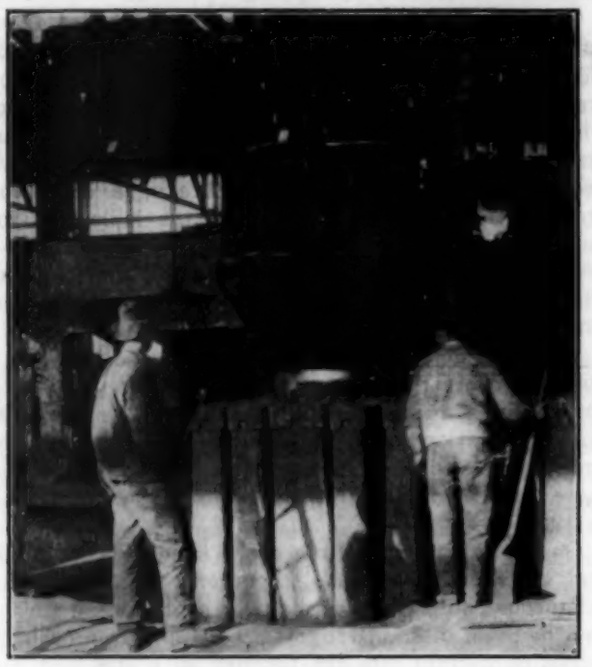


FIG. 2—TEEMING A NEST OF INGOTS. FURNACE IN BACKGROUND

per ton of product. The bottom was made of the highest grade of dead-burned magnesite and is still in good condition after 2 years of constant operation.

During the first year's operation the product went into rivet steel, plus about 30 tons of steel castings a month. Ingots cast were 6 x 6 in. in cross-section and 6 ft. in length, poured 20 to 26 on an octagonal plate, depending on the length desired. (A rectangular plate has now been installed so that the molds may be placed closer together and the combination be safer against runouts.) During this early period a large amount of forging ingots of varying sizes and composition were also made for stock, mostly 12 x 18 in. x 6 ft. ingots for main driving rods for locomotives. Crop ends and runners are rolled into bar iron for cheap material such as tie-rods or buckstays.

Early in 1921 several heats were made and cast in special ingot molds, rolled into tie plates and tested extensively to prove fitness and general adaptability. These proved so good that the shop was given an order to make 1,000,000 tie-plates, requiring about 9,000 tons of steel. Since that time we have specialized on this work and have made tie-plate steel and steel castings only. Tie-plate ingots are 9½ x 3½ in. at the bottom, 8½ x 2½ in. at the top, and 6 ft. in length, and weigh approximately 500 lb. As the small rolling mill owned by the company cannot handle pieces of this length, they must be cut in two, which is a costly operation, lacking heavy shears. To overcome this we are now experimenting with ingot molds 40 in. in length. So far the results are excellent.

Some physical tests made on the steel as rolled gave the following results:

Tensile Strength	Elongation Per Cent	Analysis C	Mn	Si	P	S	Cold Bend Test
77,840	25.0	0.25	..	0.34	0.066	0.041	1½ in. round bent flat on itself, with no check
58,974	31.3	0.16	0.61	....	.....	.....	1½ in. round bent flat on itself, with no check
112,000	12.5	0.48	0.96	0.25	0.057	.....	1½ in. round bent flat on itself, no check
64,000	28.0	0.12	0.34	0.11	0.041	.....	1 in. rivet bent flat on itself, no check

The largest money maker for the foundry is steel castings. All steel castings used by the Southern Pacific Lines are made here, the foundry thus serving the territory from Portland to Los Angeles and as far east as Ogden. All classes of castings are made, including those for ferryboats, locomotives and cars, and those needed for general repair work on shop machinery. Their average size is about 150 lb., but sizes from 1 lb. to 16,000 lb. have been made. All small castings are stacked when poured, although an attempt is always made to get the small ones in a box with a large one, thus making an easier job for the ladleman and resulting in a superior product.

Due to lack of floor space and modern equipment the making of steel castings presents several difficulties. As many castings as possible are put into every flask, and it is interesting to shake out a locomotive frame with possibly twenty small-sized pieces sticking to it, like ornaments on a Christmas tree. All large cores are made at the iron foundry, several blocks away, and brought to the steel mill in small auto trucks, where they are set and dried by means of a gasoline torch. All dry sand molds are dried by small wood or charcoal fires, and are given finishing touches with the torch before closing. Most of the smaller sized work is made in green sand molds made of heap sand properly tempered with molasses water. The core sand mixture used is silica sand, one wheelbarrow; fireclay, two shovels; sawdust, two shovels; molasses water, one pint; molasses with water to suit. Dry sand molds are made of silica sand, one barrel; heap sand, one barrel; fireclay, five medium shovels; molasses with water to suit. Several brands of sand have been tried, but our present stock sand is made up of equal parts of Ottawa and Monterey beach sand and is excellent for all general classes of work.

Special Blank for Locomotive Frames

One type of casting which may be of interest is a special blank for locomotive frames. This piece is 10 ft. 5 in. long, 3 ft. wide, and 5 in. thick, with an auxiliary piece to increase the thickness to 6 in. From this blank it is possible to cut frame pieces for seven different types of locomotive. Its use results in a great saving of stock parts and always furnishes the necessary piece for a quick repair. We have poured this piece several ways, on the flat with heads at both ends, poured from the center; on the flat, poured uphill 18 in. from the bottom, with two large heads at the upper end; and on the edge from the center with four heads. The latter gives the best piece of steel.

We have also done quite a large amount of experimentation on the making of cast iron from steel scrap and find it both an easy and economical proposition. This has already been described in CHEMICAL & METALLURGICAL ENGINEERING for Feb. 2, 1922 (vol. 26, p. 270). Pig iron pays a freight rate of $17 a ton from the East by water and $22.40 a ton by rail. Add this to the cost f.o.b. furnace and then compare the sum to a conversion cost of from $12 to $16 plus scrap iron at $10! Under such conditions, synthetic cast iron is the logical source of metal for the iron foundry or for pouring castings direct.

From the general experience of the Southern Pacific Lines with the electric furnace, both from a standpoint of cost and quality, it is apparent to the writer that the future melter for the coast states, both for iron and steel, will be the electric furnace.

The System Furfural-Water—II

Mathematical Relations Governing the Concentration of Furfural From Its Solutions by Distillation—Practical Application of the Results of These Studies to the Problem of Recovering Furfural From the Dilute Solutions Obtained Commercially*

By GERALD H. MAINS
Color Investigation Laboratory, Bureau of Chemistry

FROM such a liquid-vapor, or solution-distillate, composition diagram,[15] as has been demonstrated by Lord Rayleigh,[16] the amount of distillate that must be collected in order to obtain any given portion of the furfural contained in the original solution can be readily calculated.

Following closely Lord Rayleigh's mathematical treatment of the subject, with only such changes as apply to this special case: Let w be the weight of solution remaining in the flask at any one time, and y the weight of furfural in the solution. The composition of solution, or abscissa, ξ, of the curve is $\frac{y}{w}$. As the distillation proceeds for a short time w becomes $w + dw$ and y becomes $y + dy$ (dy and dw being negative), and the composition of the vapor (or distillate), that is, the ordinate, η, of the diagram, is $\frac{dy}{dw}$. Thus

$$\xi = \frac{y}{w}, \quad \eta = \frac{dy}{dw} \tag{1}$$

The relation between the composition of solution and distillate as given by the curve may be expressed as

$$\eta = f(\xi) \tag{2}$$

$$\text{Now from (1)} \quad y = w\xi \tag{3}$$

$$\text{then } \frac{dy}{dw} = \frac{d\,(w\xi)}{dw} = \eta = f(\xi) \tag{4}$$

$$\frac{\xi dw + w d\xi}{dw} = f(\xi) \tag{5}$$

$$\frac{dw}{w} = \frac{d\xi}{f(\xi) - \xi} \tag{6}$$

$$\text{Whence } \log \frac{w}{w_0} = \int_{\xi_0}^{\xi} \frac{d\xi}{f(\xi) - \xi} \tag{7}$$

When the composition of solution, ξ, is small, say up to 3 per cent for furfural and water, the curve does not deviate much from a straight line. The relation may then be written

$$f(\xi) = k\xi \tag{8}$$

$$\log \frac{w}{w_0} = \frac{1}{k - 1} \log \frac{\xi}{\xi_0} \tag{9}$$

$$\frac{\xi}{\xi_0} = \left(\frac{w}{w_0}\right)^{k-1} \tag{10}$$

That is, when a certain amount of solution is distilled off, the ratio of the final composition, ξ, to the initial composition, ξ_0, of the solution in the flask is proportional to some exponent, $(k - 1)$, of the ratio of the weights of the final and initial solutions, w and w_0, and this exponent is determined by the slope of the curve.

Calculating the value of k from the data for the lower portions of the curve, it will be seen that k is practically constant at 7.5 for solutions of less than 0.5 per cent furfural, and then gradually decreases. The value of k has decreased to 5.7 at 3 per cent furfural, beyond which concentration the curve deviates too far from a straight line to permit the use of equation (10) for any close approximation.

From these data the proportion of a dilute furfural solution of known strength which must be distilled over to secure any required fraction of the furfural can be determined. To illustrate: Given a solution containing 1 per cent furfural by weight, to obtain approximately 99 per cent of the furfural in the distillate. Using equation (10) and substituting values:

$$\frac{\xi}{\xi_0} = \left(\frac{w}{w_0}\right)^{k-1}$$

$$\frac{1}{100} = \left(\frac{w}{1}\right)^{6}$$

$$w = 0.464$$

$$w_0 - w = 0.536$$

Thus, by distilling over approximately 54 per cent of the original 1 per cent solution, the furfural concentration of the residual solution is reduced to 0.01 per cent. Nearly half of the water has been eliminated with a loss of less than 0.5 per cent of the furfural, and the concentration of the distillate has reached 1.84 per cent. By repeating this process with the distillate, it would be possible to obtain finally about 97 per cent of the original furfural and to eliminate practically all of the water simply by successive distillations. As the concentration of the furfural increases, the value of k becomes smaller and a greater proportion of the solution must be distilled over to obtain the same effect. Hence a very large number of distillations would be required and the process would be very tedious.

If it is desired only to reduce the concentration of the residual solution to one-tenth that of the original solution or to obtain about 90 per cent of the original furfural in the distillate,

$$\frac{1}{10} = \left(\frac{w}{1}\right)^{6}$$

$$w = 0.681$$

$$w_0 - w = 0.319$$

so that only 32 per cent of the original 1 per cent solution need be distilled over. Two-thirds of the water is thus eliminated, with a loss of only 6.8 per cent of the furfural, and at the same time the concentration of the distillate is brought to practically 3 per cent. Repetition of the distillations, each time reducing the concentration of the residual solution to one-tenth that of the initial solution, would eliminate practically all

*For Part I see CHEM. & MET. ENG., vol. 26, No. 17, p. 779, April 26, 1922.

[15] See Part I of this article.

[16] Lord Rayleigh, *Phil. Mag.* [6], vol. 4, p. 527 (1902).

of the water in seven or eight distillations, but would entail a loss of approximately 25 per cent of the furfural.

Table VIII gives the values of k for solutions up to 3 per cent, and the percentage of solution that must be distilled over in each case to reduce the concentration of the residual solution one-tenth or one-hundredth of the initial concentration.

Fractional Distillation

By using a somewhat different procedure the major portion of the furfural can be recovered from a dilute solution by comparatively few distillations. Use is made of the data here given to ascertain how much solution may be left in the still without appreciable loss of furfural. The distillate, however, which is constantly weakening during the distillation, is split into fractions.

Furfural solutions weaker than 1.5 per cent are brought up to that concentration by straight distillation, using the data given. When the concentration of furfural solution has reached 1.5 per cent the distillate from it will be approximately a 10 per cent solution, which will deposit a furfural layer upon cooling to room temperature. This furfural layer is separated before any additional weaker distillate comes over to dissolve it. In this manner fractions consisting of wet furfural, saturated solution and two or more weaker concentrations are obtained. The weaker fractions are redistilled and their distillates distributed among the more concentrated fractions. Starting with a solution as dilute as 1 per cent and making use of this method, four or five distillations will usually suffice to obtain about 95 per cent of the total furfural in the form of wet furfural and saturated solution. The wet furfural can be practically freed from water in one distillation, and the small volume of saturated solution can be saved for combination with other lots.

The process just described is simply a mechanical approximation to the process carried out automatically by a fractionating column, and the use of a properly designed column will give a direct separation of wet furfural from dilute solutions in one operation.

Practical Applications

The question will arise as to the limitations in the application of the data here presented to the concentration of the dilute furfural solutions obtained in the commercial manufacture of furfural.

The preparation of furfural by the digestion of corncobs with 20 to 30 per cent sulphuric acid has given satisfactory results on a small factory scale in this laboratory. In co-operation with Dr. F. B. La Forge, the use of superheated water alone as a digestive agent is now under investigation. In France hydrochloric acid solutions have been used to digest kapok and other pentosan-containing materials for the manufacture of furfural. The hydrochloric acid process may be disregarded because of its commercial impracticability for producing furfural at a very low price.[17]

With the other two methods the condensed distillate from the digestion is a dilute furfural solution with the following approximate composition: furfural, 1 to 3 per cent; acetic acid, 1 to 2 per cent; acetone, 0.02 to 0.04 per cent; water 95 to 98 per cent, with small amounts of sulphuric and sulphurous acids carried over in the case of the sulphuric acid digestion.

The acetic acid may be separated by neutralization with lime before the distillation of the solution. This treatment, however, gives rise to much foaming during distillation, and it is better to recover the acetic acid from the residue after concentrating the furfural. The presence of the dilute acetic acid does not interfere with the distillation or separation of the furfural from the solution. Whereas acetic acid is carried over in the distillate, its concentration there is somewhat smaller than in the original solution and the greater part of the acetic acid is concentrated in the residual liquid in the still.

On the other hand, the acetone, although present in very small quantities, interferes somewhat with the separation of the furfural. It lowers the boiling point of the furfural-water system, and, being completely miscible with furfural, increases its solubility in the first portions of the distillate. During distillation the acetone portion comes off at slightly below 97 deg. C. and is a clear solution. When the temperature reaches 97 deg. C., the distillate becomes milky, owing to the separation of the furfural layer. When the temperature has reached 97.9 deg. C., the distillate will be practically free from acetone. The acetone portion must be removed as soon as the distillate appears turbid, and then concentrated separately. Although small in volume, it is rich in furfural. The remainder of the original solution behaves during the rest of the distillation simply as a pure furfural-water solution.

TABLE VIII—MATHEMATICAL DATA ON THE CONCENTRATION OF FURFURAL BY DISTILLATION

—Per Cent Furfural by Wt.— Composition of Solution	Composition of Distillate	Ratio: Comp. of Distillate to Comp. of Solution	Per Cent to Be Distilled Off to Reduce Conc. to Given Fraction of Initial Conc.	
ξ	η	$\frac{\eta}{\xi} = k$	$\frac{\xi}{\xi_0} = \frac{1}{10}$	$\frac{\xi}{\xi_0} = \frac{1}{100}$
0.2	1.5	7.5	30	51
0.4	3.0	7.5	30	51
0.6	4.4	7.3	31	52
0.8	5.8	7.2	31	53
1.0	7.0	7.0	32	54
1.5	10.0	6.7	34	56
2.0	12.7	6.4	35	58
2.5	15.0	6.0	37	61
3.0	17.1	5.7	39	63

Traces of sulphuric or sulphurous acids cause no difficulty. If an appreciable quantity of sulphuric acid has been carried over during the digestion, however, it tends, upon being heated, to react with the furfural to form resinous substances, and should be partly neutralized.

Small quantities of furfural may be concentrated by several distillations as previously described, but in manufacturing furfural in large quantity an efficient fractionating column is essential. On the small-scale work at the Color Laboratory, making as much as 5 lb. of furfural a day, an ordinary copper column filled with porcelain balls has been used with fairly satisfactory results. For larger scale operations a special column is being designed.[18] Such a column will deliver three main fractions: *A*, containing acetone, furfural and water, boiling from 60 to 97.9 deg. C.; *B*, containing furfural and water, boiling from 97.9 to 100 deg. C.; and *C*, the remainder, boiling at 100 deg. C. and above, and consisting of water containing acetic acid and small

[17] Furfural is now being made in this country on a commercial scale by the Miner Laboratories, Chicago, Ill., but the details of the process are not available.

[18] Continuous furfural distillation apparatus, designed by the aid of the data presented, has just been placed in operation at the Color Laboratory. It has a capacity of 50 lb. of furfural per day when handling a 2 per cent solution.

amounts of formic, and perhaps sulphuric and sulphurous acids. The furfural layers are to be separated from fractions *A* and *B*, and the residual portions of these fractions continuously returned to the upper portion of the column. The crude, or wet, furfural obtained from such a column is purified by adding a small amount of sodium carbonate to the liquid, distilling, and, after the water has separated in the first portions, collecting the distillate coming over at a constant boiling point. This final distillation can also be conveniently carried out in a vacuum still.

Summary

The corrected boiling point of pure furfural has been found to be 161.7 deg. C. at 760 mm., and its density $D^{\frac{20}{4,\ Vac.}} = 1.1598$ and $D^{\frac{25}{4,\ Vac}} = 1.1545$. The composition-density tables at 20 and 25 deg. C. have been determined for solutions of furfural in water up to the saturation concentration.

Making use of these tables as a method of analysis, the mutual solubility curves at atmospheric pressure, and the boiling point and condensation point curves, or the liquid-vapor phase boundaries, have been determined for the system furfural-water.

The curve showing the relation between corresponding solution and distillate composition for dilute furfural solutions has been carefully determined with the elimination of errors due to partial condensation in the still head.

The mathematical relations for the distillation of mixtures as developed by Lord Rayleigh are discussed with reference to the case of furfural and water.

The application of these physicochemical data to the commercial concentration of the dilute furfural solutions obtained during the manufacture of furfural is discussed.

Sources of Thorium in Ceylon

Ceylon offers several possible sources of thorium, used in the manufacture of gas mantles, in the deposits of monazite sand, containing thorium, thoria, thorianite and raw thorite ore, or black thorium silicate, according to the report of Consul M. M. Vance from Colombo. Monazite sand was shipped from Ceylon in the amount of 72 long tons, valued at 40,000 rupees, in 1920. A British firm controlled the plant utilizing this particular deposit, and because of financial difficulties no shipments were made subsequently. Deposits of monazite sand are claimed to exist in practically every part of the Ceylon coast, and the Department of Mineralogy there is anxious to increase the market for the product and is willing to erect more machinery for extracting the thorium if successful in extending the market.

Thoria and thorianite have been offered in limited quantities at low pre-war figures, which will be furnished, together with the name of the person offering these minerals, upon application to the Bureau of Foreign and Domestic Commerce. Small samples of these two ores have been referred to the United States Geological Survey. The same merchant was reported as being able to furnish small quantities of what was thought to be thorite, or black thorium silicate, to purchasers in the United States. Thorite was formerly very generally used in obtaining thorium for gas mantles.

Investigation of Georgia Clays by Bureau of Mines

The kaolins and bauxites of Georgia occur principally in the coastal plain, the belt running diagonally across the state from east to west. The railroad lines of the Central of Georgia reach about 80 per cent of the white clays and bauxites of the coastal plain. The white clays are being mined at a few points, principally at Gordon, Claymont, McIntyre and Butler. These clays are sold principally to the filler trade. Bauxite mining has been carried on in the Cuthbert, Toomsboro and Andersonville districts and the bauxite is used principally in the manufacture of alum, abrasive and aluminum. The value of the clays and bauxites for ceramic purposes is little known. The investigation undertaken by the Ceramic Station of the Bureau of Mines, Columbus, Ohio, in co-operation with the Central of Georgia R.R., will consist in experiments to devise better refining methods and to test the physical properties of the different separations obtained. For this purpose a small-size refining plant is being constructed at the Ceramic Station.

Behavior of Clays Under Actual Working Conditions to Be Studied

This equipment is capable of handling from 500 to 1,000 lb. at a time. Evidently some of the clays will show promise of being valuable for pottery making purposes. After the laboratory tests are completed by the Bureau of Mines about 400 lb. of such clays will be taken into a commercial pottery and made up into pottery wares under practical working conditions, and the behavior of such clays as to working properties, color, percentage losses, etc., will be carefully studied. The white clays and bauxites of the coastal plain are closely associated, and this close association indicates that the bauxites were derived from the alteration of kaolins. Deposits are found which vary all the way from kaolin on the one hand to bauxite on the other. Some of these materials, which are higher in alumina than kaolin, show better refractory properties than No. 1 fireclays. Such clays, termed "bauxitic clays," undoubtedly would be most valuable for the manufacture of refractories superior to those now being made from fireclays. The refractory properties of such materials are to be studied, such as fusion temperature, load carrying capacity and resistance to spalling.

English China Clay Compared With Georgia Kaolin

English china clay is preferred to Georgia kaolin by many American potters. In comparing the two it is found that the English clay disintegrates in water more readily, produces a body which casts more satisfactorily, gives lower drying and bisque losses and requires less linseed oil to produce a spreading condition for oilcloth and produces a paper of better finish and more resistant to moisture. In preliminary work by the Bureau of Mines it was found that after calcining Georgia kaolin to low temperatures (500-600 deg. C.) it possesses properties similar to the English china clay—i.e., its adsorptive properties are decreased to that of the English china clay and the rate of capillary flow and the permeability of water is increased. Further tests are to be made to determine its commercial feasibility. The effects of aging the calcined clay in air and water are to be studied to determine how far the calcined clay will revert to its original state and also to study the varieties produced by different calcination tempers.

Reduction of Fuel Wastes in the Steel Industry*

By F. G. Cutler

IN ORDER to show the relative proportion of the energy in the shape of heat or power required for the manufacture of steel that is obtained from the fuel byproducts of the manufacturing process, the following figures have been prepared showing the quantity of heat derived from the byproducts of the manufacture of pig iron.

In the production of pig iron, from under 1,800 to over 3,000 lb. of coke is used. Part of the heat energy of this coke is required to reduce the ore to pig iron. Part is lost in radiation. Approximately one-half is available in the form of blast furnace gas. Most of this gas is used under boilers for the production of steam.

As blast-furnace gas leaves the top of the furnace it usually has a temperature of from under 300 to over 600 deg. F., generally averaging about 400 deg. F. At this latter temperature the sensible heat of the gas is equivalent to about 8 B.t.u. per cubic foot of gas at 62 deg. The B.t.u. per cubic foot of blast-furnace gas according to Brassert is $62.5 + 0.016R$, where R = lb. of dry coke per ton of pig iron; and including sensible heat of the gas at 400 deg. F. would be equal to $70.5 + 0.016R$. The cubic feet of gas per ton of pig iron (as shown by Brassert) is equal to $71.4R$, so that in the top gas from a furnace at 400 deg. F. the B.t.u. per ton of iron is $1.142R^2 + 5033.7R$. Brassert also gives the cubic feet of air per pound of coke equal to $51.4R$, so that both gas production and the blast requirement bear a direct ratio to the coke consumption of the furnace per ton of iron. The figures, so far as the author has been able to discover, are applicable to all blast furnaces using coke as fuel.

Heat Necessary for the Blast

The blast is heated in stoves under pressure, and the heat required per cubic foot of blast is proportional to the rise in blast temperature in the stove and inversely proportional to the efficiency of the stove, which is usually considered to average 60 per cent. After the necessary gas is used to heat the blast, the remainder can be measured in the shape of power.

The blast supplied from the blowing engines is heated by compression to about 150 deg. F., varying somewhat with blast pressure, etc., and is usually heated in the stoves to from 1,150 to 1,350 deg. F. In the following calculations it has been assumed that 0.02 B.t.u. is required per cubic foot of blast per deg. F., that the blast is heated in the stoves to 1,250 deg. F., that the average overall stove efficiency—i.e., ratio of heat given to the blast to the heat in the gas—is 60 per cent and that 55 cu.ft. of blast is heated per pound of coke charged.

The heat required in the gas for heating the blast for 1 ton of pig iron to a temperature of 1,250 deg. F. can therefore be expressed by the following formula where H = B.t.u. per lb. of coke burned in the blast furnace.

$$H = \frac{(1250 - 150) \times 0.02 \times 55R}{0.60} = 2020R$$

The heat in gas per ton product after the blast is heated is, therefore, $1.142R^2 + 3013.7R$. For other top temperatures and blast temperatures the constants will change slightly.

Boiler Horsepower-Hours Available

In 1 boiler horsepower-hour there is 33,305 B.t.u., and assuming that the "standard" efficiency of blast-furnace-gas-fired boilers is 66.6 per cent, in 1 boiler horsepower-hour $33,305 \div 0.666 = 50,000$ B.t.u. would be required in the gas, so that the boiler hp.-hr. per ton would be

$$\frac{\textit{Surplus B.t.u. per ton iron}}{50{,}000\ \textit{B.t.u.}}$$

As the blast-furnace product is usually expressed in tons per day, the average boiler horsepower per hour generated from blast-furnace gas under the above conditions can be expressed by the formula:

Average boiler horsepower per hour per ton of pig iron per day

$$= \frac{1.142R^2 + 3013.7R}{50{,}000 \times 24}$$

The following table shows the boiler horsepower-hours per ton of pig iron for several coke rates as calculated from the above formula:

Pound of Coke Per Ton	Boiler-Horsepower-Hours Per Ton Product	Boiler-Horsepower-Hours Per Ton Per Day
2000	211	8.8
2200	242	10.1
2400	276	11.5
2600	310	12.9
2800	348	14.5
3000	386	16.1

To furnish the blast to the furnace with either high-pressure condensing, turbo-blowers or reciprocating steam engines requires about 70 boiler hp.-hr. per ton of coke burned in the blast furnaces, and to operate the various furnace auxiliaries, such as pumps, air compressors, steam bells, mud guns, hoists, etc., requires from 15 to 25 boiler hp. per ton of product, so that after the furnace requirements have been met, there is available for the generation of power from 100 to 250 boiler hp.-hr. per ton of pig iron, depending on the coke burned in the furnace.

At 2 kw. per boiler hp.-hr., this means that from 200 to 500 kw.-hr. per ton of pig iron is possible with steam equipment from the surplus gas from the blast furnaces.

Heat Required in Steel Manufacture

The manufacture of steel from pig iron in the open hearth requires heat for melting scrap and fluxing the impurities, and power for the various operations incident to this process. The quantities of heat and power required vary materially with different plants on account of difference in equipment, practice, etc., but for the purpose of this paper it will be assumed that a ton of ingots requires 1 ton of pig iron plus enough scrap to offset the losses, and this work requires from 5,000,000 to 9,000,000 B.t.u. and an expenditure of from 20 to 30 kw.-hr. per ton. This ton of ingots will make about 0.85 ton of blooms, and the heating in soaking pits will require from 1,500,000 to 3,500,000 B.t.u. per ton of steel depending upon the temperature of the steel arriving at the pits, rate of operation, etc., and the rolling of the ingots into blooms will require from 40 to 60 kw.-hr. per ton. From the blooming or slabbing mill the material, usually reheated at an expenditure of from 2,500,000 to 6,000,000 B.t.u. per ton, is furnished to finishing mills, the power required, depending on the reduction of section, temperature of rolling, etc., varying from 35 to over 300 kw.-hr. per ton.

*Abstracted from *Mechanical Engineering*, April, 1922. Paper to be read at spring meeting, A.S.M.E.

TABLE I—HEAT BALANCE FOR MANUFACTURE OF 1 TON OF PIG IRON

From the coke plant delivering 1 ton of coke there result the following fuel byproducts for consumption in the steel plant after the heat and power requirements of the byproduct plant have been met:

12 gal. tar at 162,500 B.t.u. per gal., B.t.u.	1,950,000	
30 lb. of coke breeze at 12,000 B.t.u per lb., B.t.u.	360,000	
10,000 cu.ft. gas at 500 B.t.u. per cu.ft. (net value), B.t.u.	5,000,000	
Total per net ton coke		7,310,000
Heat available per ton pig iron	B.t.u.	B.t.u.
In tar from byproduct plant	2,435,000	
In coke breeze from byproduct plant	450,000	
In surplus gas	6,250,000	
Surplus from byproduct plant		9,135,000
In blast-furnace gas		19,635,000
Required for blast heating	5,000,000	
Required for blowing equipment	4,400,000	
Required for blast-furnace operation	1,000,000	
Required for total blast furnaces		10,400,000
Surplus from blast furnace plant		9,235,000
Total heat energy from byproducts		18,370,000
Heat required for steel plant		
Open hearth (pig iron to ingots)		
Melting (approx.)	7,000,000	
Power, 25 kw. at 25,000 B.t.u. per kw.-hr.	625,000	
Total heat consumption		7,625,000
Roughing Mill		
Heating (approx.)	2,000,000	
Power, 50 kw.-hr.	1,250,000	
Total		3,250,000
Finishing Mill		
Heating (approx.)	4,000,000	
Power, 100 kw.-hr.	2,500,000	
Total for finishing		6,500,000
Total heating requirements	13,000,000	
Total power requirements	4,375,000	
Total		17,375,000

Utilization of Industrial Wastes

Waste heat from open-hearth and heating furnaces and kilns is utilized for the production of steam, and otherwise waste steam is utilized in low or mixed pressure turbines for the production of power, but as these subjects have been discussed many times and are not peculiar to the steel industry, they will not be discussed except to say that while these economies are many times worth while in existing plants, very few new installations as designed include waste-heat boilers with furnaces, or low-pressure turbines as integral parts of new power plants.

Surplus byproduct gas, after the ovens are heated, is sold for use as domestic fuel, etc., replacing natural gas, water gas, etc., and is used in the steel plant for melting steel in the open hearth and for various heating operations in the steel industry. In former years this material was considered as having only nominal value and it was but rarely that any attempt was made to utilize it efficiently.

With the advance in fuel prices, shortage of natural gas, etc., and also largely due to special heating requirements connected with the manufacture of artillery and ammunition during the war, a number of combustion systems were developed that by more or less accurately regulating the proportion of air to gas have greatly increased the combustion efficiency of heating furnaces, and the control of combustion has been found of great importance in the maintenance of economy.

Dust coke breeze, from the coke plant—i.e., the material through a ½-in. screen—is used to cover molten pig iron in transit from the furnaces and in making bottoms of soaking pits and heating furnaces. A great deal of this material which was thrown away or more or less inefficiently burned on hand-fired grates, or, by mixing with slack, on mechanical stokers, is now more efficiently burned by itself, on traveling-grate forced-blast stokers.

Tar, either before or after the creosote oils have been removed, has been found to be a very good fuel for open-hearth furnaces, either by itself or in conjunction with byproduct gas, and has been used for steam production either as an auxiliary fuel on blast-furnace boilers or by itself, and its use has been proposed to heat byproduct ovens, thus releasing additional gas otherwise required for heating the ovens.

Heat Balance

Table I gives an example of the approximate heat balance of 1 ton of pig iron as used in the steel plant, using average figures, and based on an average coke consumption in the blast furnace of 2,500 lb. of coke per ton of product.

Necessity of Heat Conservation

From Table I it will be seen that the total heat from the byproducts of a ton of pig iron is more than sufficient to finish the average ton of steel, but upon inspection of the table it will be found that the heating requirements have not been met from tar and byproduct gas, while the average power requirements are more than met from blast-furnace gas and coke breeze.

It therefore becomes very desirable to reduce the heating requirements for production of steel by using more efficient heating furnaces and to conserve all possible heat by charging hot steel into the soaking pit and reheating furnaces, in order to reduce the quantity of fuel required for supplementary heating.

The production of gas at the byproduct plant is practically uniform, while the consumption at the steel plant is variable and as a result the gas pressure at the steel plant (usually some distance away from the byproduct plant) is variable. As gas holders of sufficient capacity to absorb the fluctuations have not been found advisable, it becomes necessary to schedule the use of gas by consuming departments in order partly to equalize the consumption. In many cases it is advisable to use byproduct gas under boilers (although it is more valuable for other purposes) in order to prevent or reduce its waste, as it is easier to change from gas to coal on boilers than to fire up producers.

One of the most important problems of the steel plant manager and engineer is so to regulate the production and consumption of the various fuels occurring as a byproduct of steel-plant manufacture that the consumption of raw coal in producers or under boilers that would otherwise be sent to the byproduct plant is a minimum, for the reason that the byproducts from the coal, coked in the byproduct plant, usually exceed any possible return as fuel.

Japan Building Dye Industry

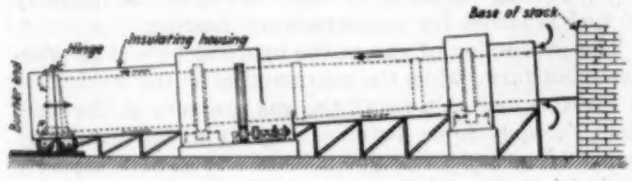
The *Indian Textile Journal*, December, 1921, is authority for the statement that the Japan Dyestuff Co. since its establishment has produced about one hundred different kinds of dyes, of which forty are already on the market. Some additional kinds are also to be put on sale, including scarlet for silk, water blue, pure indigo, acid brilliant red, and direct black 300 per cent. The last mentioned is claimed to be better than the American product. Moreover, the cost of production is said to be much less than in America.

Recovery of Radiated Heat From a Rotary Kiln or Drier

IN THE operation of a rotary cement kiln a quantity of the heat supplied is wasted to the surrounding air by radiation through the kiln shell. This has two undesirable results. First, there is a direct loss of fuel because of the extra amount necessary to make up for this radiation loss. Second, most kilns are located within a building, and the escape of this heat into the building makes working conditions trying and reduces the effectiveness of the workers.

There has been an attempt to eliminate these disadvantages by placing insulation between the brick lining of the kiln and the steel shell. This has not been entirely successful, for where high internal kiln temperatures are encountered the effect of heat on the brick lining must be considered. It is evident that if the heat loss from the brick is reduced, the temperature of the brick is increased. This temperature must not be permitted to reach the point which would reduce its life, yet sufficient insulation should be used to save the maximum heat possible. Kiln linings last only a short time at best, and the decrease of this time by such a misapplication of insulation is sufficient to condemn the method.

In seeking a means of recovering this heat without getting into other difficulties, Johns-Manville, Inc., suggests that the practical method is to surround the kiln with an insulated housing such as is shown in the accompanying sketch. This housing consists of an



HOUSING TO SAVE RADIATED HEAT

angle-iron frame around the kiln, covered with insulating material. The space between the insulation and the kiln shell is sufficiently restricted so that the velocity of the air drawn through this space is high enough to insure the heat being carried away, without increasing the shell temperature. Air is taken into this "live" air space at the open end of the housing, which is at the upper or entrance end of the kiln. It is then drawn through the housing around the shell and into the kiln at the delivery end, where it supplies the necessary air for combustion of the fuel.

Losses by Radiation in Cement Kiln

In developing this housing a study was made of the losses incurred through radiation. It was found that loss through the exposed surfaces of kilns often amounts to more than 1,000 B.t.u. per sq.ft. of surface per hour. Assuming continuous operation for 300 days or 7,200 hours per year, this gives a loss through each square foot of radiating surface equivalent to the consumption of 600 lb. of coal. As the heated air from the housing can be utilized in combustion of the fuel or in other ways so that about 90 per cent of the radiated heat is recovered, the saving in fuel can be made to amount to about 540 lb. yearly per sq.ft. When this heated air is used in place of cold air for combustion purposes in the kiln, conditions are bettered, as the fuel is not brought into contact with cold air which must be heated before combustion can take place.

The insulating housing can be provided with windows at any desired places in its sides, so that conditions within may be observed while the kiln is in operation. The comparative darkness within the housing makes it easier to notice hot spots in the kiln shell than if the kiln were located in the open. This enables repairs to be made to the kiln lining before the heat has damaged the steel shell.

Other Methods of Using the Recovered Heat

If it is not desired to use the heated air from within the housing for purposes of combustion in the kiln, it can be used in a number of other ways. For example, the clay used in the manufacture of some cements is dried before use, and the drier can be heated with this recovered heat. This use is advantageous in a plant where the heated air for kiln combustion is obtained from the clinker cooler. In other cases it can be employed for heating purposes, or such other uses as suggest themselves from plant conditions.

This method of recovery of radiated heat, which up to the present has been developed with rotary cement kilns in view, could well be applied to rotary and stationary driers and various types of industrial furnaces and kilns. In some of these applications the heat recovered would make an appreciable saving in fuel costs. In all cases where the equipment is located within doors general plant conditions could be improved by the reduction of the temperature in which it is necessary for men to work.

Manganese and Manganiferous Ores in 1921

The final statistics of the production of domestic manganese and manganiferous ore in 1921 are summarized by H. A. C. Jenison, of the U. S. Geological Survey, in the following tables:

MANGANESE ORE SHIPPED FROM MINES IN U. S. (EXCLUSIVE OF FLUXING ORES)

Mn Content of Ore, Per Cent	No. of Shippers 1920	No. of Shippers 1921	Gross Tons 1920	Gross Tons 1921	Value 1920	Value 1921
35 or more	56	14	94,420	13,531	$2,396,235	$495,097
10-35	31	6	357,279	8,439	1,450,518	$42,755
5-10	6	3	279,687	62,670	644,572	$147,576

MANGANESE ORE IMPORTED INTO THE UNITED STATES IN 1921*

Country	Quantity (Gross Tons)	Value
Africa	8,453	$27,198
Australia	.....	8
Brazil	262,468	1,952,848
British India	113,730	734,516
Costa Rica	588	17,658
Cuba	34	679
Honduras	14	140
Hongkong	7,319	131,052
	†392,606	†2,864,099

* Taken from records of the Bureau of Foreign and Domestic Commerce.
† About 8,700 tons, valued at $502,000, also reported as imports of manganese ore, but as the average value ranged from $46 to $128 per ton, these figures probably represent either spiegeleisen or ferromanganese.

Dyes From Kaoliang Bran

A method of securing dye from kaoliang bran has been discovered, according to a report to the Department of Commerce from Consul Kirjassof, Dairen. Kaoliang is a kind of sorghum, or giant millet, resembling broom corn. A mixture containing seven parts bran and the remainder consisting of soda, sulphate, etc., will produce the dye which is patented for brown and black, and also patent applied for to cover blue-black. Kaoliang bran may be obtained in practically unlimited quantities in Manchuria, delivered at stations of the South Manchuria Railway at approximately 1.80 yen per 100 kin.

Synopsis of Recent Chemical & Metallurgical Literature

Season Cracking.—In a voluminous paper[1] on "Testing Artillery Cartridge Cases," J. Burns Read and S. Tour state that season cracking, or corrosion cracking, of 70:30 brass cannot be predicted by chemical analysis, tensile or hardness tests or microscopic examination. Immersion in a 1.5 per cent mercurous chloride solution for 4 hours or in a 10 per cent mercurous nitrate solution for 15 minutes will open cracks in some articles. The authors believe that a season crack is the result of slow corrosion weakening the metal until its internal stresses exceed the tensile strength. Corrosion by mercuric salts produces accelerated "season" cracks probably by rapid and preferential amalgamation at the grain boundaries. While the test was vigorously opposed by manufacturers early in the war, the consensus now is that it is the most informative of all tests, both to indicate the quality of the finished piece and also to control the methods of manufacture.

Season cracking occurs in hard or soft pieces which are unequally strained in neighboring portions, and this strain can be removed by reheating to 500 deg. F. (260 deg. C.) for 1 hour, even though it causes no observable change in ordinary physical tests. Slight wear in properly designed tools may cause cracks by putting less work into one portion of the cartridge case than intended. Local strains caused by dirt and chips producing scratches on the metal will also cause season cracking.

Corrective measures vary, but some combination of the following usually suffices:

1. Increase the work during the last redraw, and anneal at the same temperature as formerly, if the increased tensile strength is permissible.
2. Increase the temperature or time of anneal if the lowered tensile strength is permissible.
3. Increase both work and anneal to relieve the strain without change in tensile strength.
4. Redesign the drawing and heading operations.
5. Use a final low-temperature anneal.

The last alternative is particularly effective and should be a matter of routine. The furnace could be heated by waste flue gas from other annealing furnaces, and the conveying done automatically.

Causes of Failure of High-Speed Tools.—A summary of an address by J. F. Kayser before the Birmingham (England) Metallurgical Society was printed in *Iron and Coal Trades Review* for March 31, 1922, p. 458. It is recalled that the method of failure depended in large measure on the shape of the tool; given a correct tool, however, there were two typical causes of failure: (*a*) abrasion of the chip furrowed the tool some distance behind its point, removing the support of the cutting edge which was later pushed away with the chip; and (*b*) up to time of failure there is practically no sign of wear, when suddenly the cutting edge is forced downward and into the lower part of the bar. These two types are found when doing both heavy and light work.

Inquiring into the belief that the "breaking-down temperature" was a measure of tool efficiency, tools of proved analyses were made, bored for thermocouple junctions, and provided with electrical connections whereby both the tool and the work could be heated. It was found directly that the cutting operation raises the temperature of both the work and the tool nose sufficiently to cause a pronounced change in their relative physical properties and the ability of the tool to cut the work was seriously affected. When the tool was first put to work there was a fairly rapid rise in temperature, quickly reaching a point where it remained constant until the moment of failure, when it again sharply increased. An annealed steel bar (Brinell 260) was mounted in a lathe, and a hot tool fed into it. With increasing temperature the cutting efficiency fell off, and at 500 to 550 deg. C. the tool refused to cut at all, even though the cutting edge was doubtless chilled by contact with the cold bar. However, if the work and tool were both at 600 deg. C., the tool readily cut for several minutes at a rate of 20 ft. per minute, $\frac{1}{16}$ in. deep and $\frac{1}{16}$ in. feed.

The Production of Gasoline by Cracking Heavier Oils.—The ordinary processes of refining crude petroleum yield a series of products differing widely in properties and commercial desirability. Cracking is already a factor of importance in the commercial production of gasoline. The experiments described in Technical Paper 258 of the Bureau of Mines, by E. W. Dean and W. A. Jacobs, issued in April, 1922, were not intended to cover the development of any one commercial process, nor do their results answer all the questions that arise concerning cracking. A number of important facts which do not seem to be generally recognized by those developing or operating cracking processes have, however, been demonstrated. The results of the experiments described in this report may be summarized briefly as follows:

1. Evidence obtained tends to support the theory that cracking is a contact-surface reaction, as the controlling temperature is that of the furnace walls rather than of the current of oil vapor.

2. (*a*) The range of temperature favorable for the commercial production of gasoline seems, for any given oil and any given pressure and rate of feed, to be within temperature limits considerably less than 50 deg. C. apart. With oil *A*, a distillate derived from Pennsylvania crude, the yields of gasoline at 550 deg. C. were probably a little lower than would have been acceptable in commercial practice. At 580 deg. the losses in recovery of cracked oil were excessive for commercial operations except possibly when the original fuel oil was exceedingly cheap or the plant was in a locality offering a profitable market for the gas formed.

(*b*) The favorable temperature range is apparently not the same for all oils and seemed to be at least 20 deg. C. higher for a Humble field, Tex., distillate (oil *D*) than for the Pennsylvania gas oil (oil *A*).

(*c*) The present experiments indicate that the degree of cracking possible with contact surfaces at 500 deg. C. or lower is negligible for the rates of feed employed.

3. Pressure is favorable for cracking, at least up to the highest limit (200 lb. gage reading) used in the present experiments. Limitations affecting the use of high pressure are apparently those imposed by the mechanical strength of the equipment rather than by the course of the reactions involved. It appears, however, that the advantage gained by increasing pressure from atmospheric to 100 lb. gage reading is notably greater than the advantage gained by a further increase to 200 lb. One hundred pounds is generally regarded as safe pressure for commercial size units, and fortunately seems high enough to yield a large share of the possible benefit to be derived from high pressure.

4. The quantity of carbon formed for the range of conditions favorable for gasoline production seems to be controlled chiefly by the content of high-boiling fractions, particularly so-called asphaltic material, in the oil cracked. Distillate oils deposit carbon in quantities too small to be measurable under present experimental conditions. It is believed that, in large-scale cracking operations, trouble with carbon can be obviated by using properly prepared oils, by controlling temperatures accurately, and, if necessary, by cleaning tubes occasionally by blowing out all oil vapor with steam and subsequently oxidizing any slight carbon deposit by a brief blowing with air. This latter treatment has been used in commercial sized vapor-phase cracking plants, and the present experience with light deposits of carbon indicates that it is probably efficacious.

5. On the assumption that a gasoline with an end point of approximately 430 deg. F. is to be produced, it appears that the vapor-phase cracking process can in a single treatment produce as much as 28 per cent of gasoline from a naphtha-free original oil. It is not believed, however, that this figure can be attained profitably in commercial practice, as it involves too great a loss in the recovery of

[1] *Transactions*, American Institute of Mining and Metallurgical Engineers, April, 1922.

cracked oil. It is not possible to predict what figure would prove most profitable on a commercial basis, but a yield of 20 to 25 per cent of gasoline seems reasonable and should not involve a loss in recovery of cracked oil exceeding about 15 per cent.

These figures are not impressive compared to those frequently quoted for the commercial possibilities of cracking processes, but it must be remembered that they mean a single treatment in the cracking furnace, that they exclude any naphtha that might be contained in the oil before cracking and that they are calculated on the basis of the oil originally run into the furnace instead of on the basis of the oil recovered. By taking advantage of various omissions in statement, it would have been possible to interpret present results as indicating gasoline yields as favorable as 45 to 50 per cent; but such figures, although imposing on paper, do not represent either an accurate scientific statement of results or the possibility of highly profitable commercial operations.

6. The losses in recovery of cracked oil, accounted for chiefly as gas formation, range from 10 per cent to 30 per cent. It seems possible to obtain commercially satisfactory yields of gasoline with losses not exceeding 15 per cent.

7. (*a*) The gasoline produced by vapor-phase cracking has a relatively high degree of unsaturation, the acid-absorption figures ranging from 25 to 40 per cent. The higher boiling fractions show a smaller acid absorption (lower degree of unsaturation) than the more volatile fractions. It seems, however, that the presence of olefine or unsaturated hydrocarbons is not essentially disadvantageous in the commercial utilization of motor fuel if certain associated products, probably diolefines, are removed. Such removal is undoubtedly possible and has already been accomplished in preparing Burton gasoline for the market, by properly regulated treatment with sulphuric acid. Hot filtration through Florida clay or bauxite is claimed (reference 22, p. 53) to accomplish the same purification.

(*b*) The relatively high specific gravity of some of the cracked products indicates an appreciable content of aromatic hydrocarbons. For gasolines that would be produced commercially, this aromatic content is not likely to exceed a maximum of 10 or 15 per cent and no evidence is at hand that this content is anything but advantageous.

8. The residuum from once-cracked oil does not seem to be quite as good for cracking as the original oil (see references 18 and 29). A higher temperature is probably required to bring about a desired degree of conversion, and unless the residuum is previously distilled to get rid of asphaltic, pitchy or other undesirable material, carbon trouble is likely to result. The Bureau of Mines has been advised that in one commercially operated vapor-phase cracking process no synthetic residuum is put back through the cracking furnace, the accepted practice being first to distill to dryness, then to crack the distillate. Another process of similar type passes the undistilled once-cracked residuum through the furnace, but distills it before attempting a second rerun.

9. Residuum fuel oils appear to be unfavorable material for cracking, the disadvantage, however, being excessive carbon deposition rather than failure to form gasoline. Some types of distillate oils seem to crack better than others, but no distillate oil was tried that did not seem to be satisfactory material for cracking.

10. It was shown that the recovery losses incident to a given percentage of gasoline formation were smaller when the temperature and rate of feed were relatively high than when these were lower. This seems to be a decided commercial advantage and is the reverse of what might have been expected on the basis of previous experience with cracking at very high temperatures.

Black Fractures and Graphitized Cementite.—Prof. W. Heike of Freiberg discusses "Reversed Chill and Similar Phenomena"[1] in *Stahl und Eisen*, March 2, 1922, vol. 42, p. 42. By reversed chill the author means the appearance of a rim richer in free carbon than the center of the casting. The name is derived from the fact that this is the reverse phenomenon to that encountered in chill castings where the surface is richer in combined carbon and poorer in free carbon than the center.

The author then describes specimens of iron in the museum of metallography at Freiberg. The first is a gray iron with a light colored rim and a dark center. The rim is composed of graphite, much ferrite, relatively little pearlite and steadite.[2] The center consists of graphite, pearlite and steadite, ferrite being absent. Apparently the formation of graphite has proceeded further at the surface than at the center. The second specimen, a black fractured steel containing 1.25 carbon and 0.80 silicon, has a dark rim containing temper carbon and a center consisting of pearlite and cementite without temper carbon. The rim is presumably due to a heat-treatment which the specimen has received.

Former investigators have attempted to ascribe reversed chill to a high sulphur or phosphorus content, or to oxides dissolved in the metal. Others have felt that the phenomenon is one of supercooling. None of these explanations seems to the author to be adequate.

Heike prepared two iron-carbon alloys from very pure material by remelting in a carbon resistor furnace. In these melts reversed chill was observed, even though sulphides and phosphides were not present in any significant amount in any of the materials from which the melt was made; nor was the graphite encountered in mottles after the fashion of temper carbon, thus controverting an opinion expressed by Bardenheuer.[3]

In iron-carbon alloys saturated with carbon and raised to high temperatures in graphite crucibles the author makes the unsupported assumption that iron oxide was not present dissolved in the iron. Thus he concludes that the opinion of Osann and others that oxygen is a significant factor is disproved.

Heike draws attention to a consequence of Le Chatelier's principle the application of which has apparently been overlooked—namely, "Every external influence arouses opposing forces in a system at equilibrium which strive to bring it back to its original condition." Pressure is the external influence not ordinarily considered in the equation

$$Fe_3C \rightleftarrows 3Fe + C$$

Since decomposition of cementite is associated with increase in volume, pressure should shift the equilibrium to the left—i.e., cause any free carbon to combine with iron and form cementite, thus decreasing the volume and relieving the added pressure, at least in part.

It follows that graphitization is opposed by any conditions tending to exert pressure upon the graphitizing material, or to exercise any constraint on the accompanying increase of volume. Chemical composition also plays an important part in graphitization, since graphitization accelerated by a high-silicon content—for example, when occurring in the outer layers of a casting—materially increases the pressure of these layers on the liquid or plastic center. Just how an increase in dimensions of the outer layers of a casting should exert pressure on the interior is not made clear.

Heike then refers to certain researches published by Ruer[4] regarding the formation of graphite directly from liquid iron and not from cementite. He dismisses these considerations with the statement that first the separation of such primary graphite occurs chiefly in very high-carbon alloys, and second that even though it occurred in the ordinary alloys, the separation of such graphite in the liquid must involve an increase of volume.

The author then proceeds to elucidate his thesis that the reaction $Fe_3C \rightleftarrows C + 3Fe$ will proceed only under such conditions where a material increase in pressure does not hinder it. He feels that this condition exists so long as a considerable part of the alloy is in a liquid condition. If, however, the metal has become completely solid through the freezing of the last residues of molten material, then the energy of the reaction is no longer sufficient to overcome the constraint exercised upon the equilibrium by the surrounding pressure, the possibility of expansion being there-

[1] Umgekehrter Hartguss und verwandte Erscheinungen.

[2] Iron : phosphorus eutectic.

[3] *Stahl und Eisen*, April 28, 1921, p. 569; May 26, p. 719.

[4] *Z. angew. Chem.*, Dec. 17, 1918, p. 244.

by limited or destroyed. He regards this explanation as also applying to the occurrence of cementite at the junction of several crystals in material otherwise consisting of graphite, ferrite and pearlite. He feels further that this explains why graphite formation is materially retarded in alloys relatively low in carbon, say between 2 and 3 per cent. He writes as follows:

"If we consider further the increase of volume occurring within the space of a single crystal as a consequence of graphitization, the pressure upon the still unfrozen part must increase as the freezing progresses. On the other hand, the casting as a consequence of its cooling shrinks in from the outside so that the last residue of molten material is subjected to a pressure which the graphitizing reaction can no longer overcome. In addition to external conditions the chemical composition of the iron is of consequence, inasmuch as it largely determines the energy with which the transformation of cementite into iron and carbon occurs."

Heike then shows that the location of the graphitic areas in these and commercial specimens corresponds to those areas in which compression stresses may be considered absent. No explanation is offered, however, why this phenomenon should not constitute the rule rather than the exception, nor of the peculiar occurrence sometimes noted in even the most carefully made crucible tool steel—that the axis has graphitized and the surface remains normal.

Recent Chemical & Metallurgical Patents

British Patents

For complete specifications of any British patent apply to the Superintendent, British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Cooling Coke.—A series of three patents covering the principle and apparatus for cooling coke by steam (or other gases) and utilizing the water gas thus formed.

The first specification, 173,761, covers the arrangement of the cooling chamber, Fig. 1. The incandescent coke is conveyed from the distillation plant to a hoist by buckets *e* and the truck *q*, and is tipped into a fixed chute *i*, which discharges it into the dry cooling chamber *a* provided with an outlet *c*. The chute *i* is provided with a slidably movable lip *k* connected by a rope *l* to a lever *n*, which is connected by a pulley-guided rope *p* to a hood *d* which normally rests in a liquid seal and closes the inlet *b* of the chamber *a*. The lip *k* is thus retracted when the hood is down and projects into the opening *b* when the hood is raised, the lever *n* being operated by the bucket *e* in such a way that the hood is raised when the bucket is tipped. The rails *h* of the hoist are U-shaped in cross-section and bent over at the top, the lower roller *f* engaging the outer flanges of the rails *h* and the upper roller engaging the recess between the flanges.

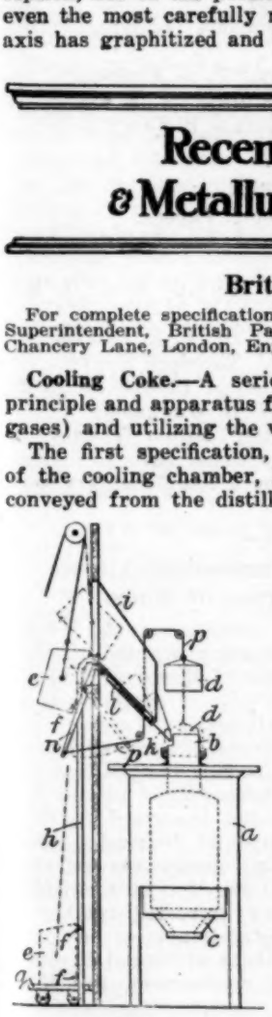


FIG. 1.

The second specification, 173,762, covers the process of cooling by means of a gas in the apparatus shown in Fig. 2. The coke is fed in known manner into a cooling chamber *a* and is cooled by a gas, preferably neutral, which is forced in a cycle through the cooling chamber and heat-exchange device. The gas enters the space *d* between upper and lower hoppers *c*, and ascends through the descending mass of coke. The lower hopper *c* is provided with slides which regulate the outlet and are symmetrically arranged always to form an outlet directly below the baffle plate *f*, which prevents the central core of the mass from descending too rapidly. As shown, forked slides *h* are used which are operated by right and left handed screws *i*. A door *g* is provided mounted on rollers *k* and is movable on rails *l*, which are pivoted at *m*, their free ends being vertically adjusted by toggle sleeves *o*. The cooling of the coke is effected progressively from the bottom, the lower layers being cooled and discharged gradually while the top layers are still incandescent, the fresh coke being added gradually.

The third specification, 173,763, covers the use of steam for cooling the coke in the apparatus shown in Fig. 3. In this process, the heat contained in the coke when it is below the temperature at which water gas is formed—namely, 600-700 deg. C.—is utilized to produce the necessary steam. The incandescent coke from the retorts passes through the cover *b* into the chamber *a*, which communicates by pipes *e*, *f* at top and bottom with a steam generator *d*, valves *g*, *h* being interposed and a blower *v* being provided to circulate the gases in the chamber *a* through the steam generator *d*. Steam is supplied to the coke mass through a pipe *i* and valve *k*, the water gas being withdrawn through a valve *m* and pipe *l* or, if it is desired that the heat of the water gas should be absorbed in the steam generator, through a valve *o* and pipe *n*. The first charge is cooled entirely by the blower *v*, thus producing steam for subsequent charges. The cooled coke is discharged at *c*.

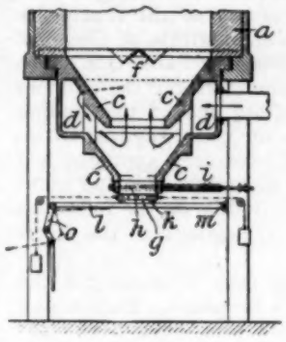


FIG. 2.

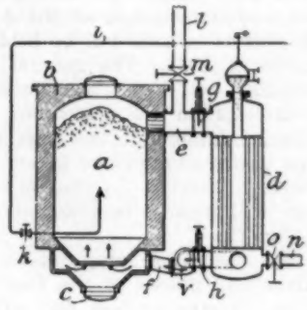


FIG. 3.

Tanning.—Instead of using iron formate for tanning hides, as described in the parent specification, a tanning material made by partial double decomposition between an iron salt and a formate is used. Examples are given of associations of ferric chloride and ferric sulphate in excess quantities with calcium and sodium formates. Calcium sulphate when formed is filtered off. Sodium chloride is allowed to remain in the liquor as an aid to tanning. In one example 10 kilos of ferric sulphate dissolved in water is treated with 2.5 kilos of calcined sodium carbonate at 30 deg. C., 4 kilos of solid calcium formate being stirred into the liquor after cooling to 25 deg. C. (Br. Pat. 173,853. Chemische Fabriken Worms Akt. Ges., Frankfort-on-Main, Germany. March 1, 1922.)

Decolorizing Carbon.—Carbon for purifying and decolorizing purposes, and especially adapted for filtering, is made from vegetable material of fibrous structure and not containing much inorganic matter, by carbonization in the closed retort with the injection of gas or steam. The product is ground in a dry state to a degree of fineness short of that at which the fibrous structure is obliterated. In an example, pine wood in a granular state is heated to about 400 deg. C. for 6 hours or less, the gaseous products being evacuated continuously. The temperature is then raised to 1,200 deg. C. for 6 hours or more, and superheated steam is passed in. In the third stage, a temperature of 1,500 deg. C. is maintained for 3 hours without injection of gas, or with injection of nitrogen. The product is ground in a ball mill using steel balls until it almost all passes through a sieve of 20 to 30 mesh, but rests on a 90-mesh sieve. (Br. Pat. 173,624. J. N. A. Sauer, Amsterdam. Feb. 22, 1922.)

Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields—Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

Strong Technical Program Announced for Chemical Engineers' Meeting at Niagara

Important papers on acid manufacture and nitrogen fixation will feature the technical program of the fourteenth semi-annual meeting of the American Institute of Chemical Engineers, which will be held at Niagara Falls, Ont., June 19 to 22, 1922. The general headquarters for the summer meeting will be at the Hotel Clifton, one of the leading hostelries on the Canadian side of the Niagara River. Special automobile and boat trips have been arranged and one entire day will be given over to sightseeing and plant visits in Toronto. A similar trip to Buffalo on the following day will include business and social sessions at the Hotel Lafayette.

An interesting program has also been arranged for the wives and guests of the Institute's members. Sightseeing trips, theater parties and afternoon teas have been substituted for the technical and business meetings of the members. The ladies' program is in charge of Mrs. A. H. Hooker, chairman for Niagara Falls, and Mrs. C. B. Morey, chairman for Buffalo.

G. Prescott Fuller, chief chemist of the National Electrolytic Co., is chairman of the executive committee. The vice-chairman is C. B. Morey, manager of the soap department of Larkin Co., Inc. Finances are under the direction of David H. Howard. The chairman of the Toronto committee is Prof. J. Watson Bain of the University of Toronto.

The members of the principal committees are as follows:

Buffalo Committee—C. B. Morey, *chairman;* C. C. Heriage, J. D. Kerr, W. L. Spalding, H. J. White, E. G. Rippel and D. H. Howard.

Niagara Falls Committee—G. P. Fuller, *chairman;* T. L. B. Lyster, H. W. Kellogg, Max Mauran, F. A. Lindbury, F. J. Tone, R. C. Snowden, and E. M. Sergeant.

Transportation arrangements have not yet been announced, although it is possible that a special trip by boat and train will be arranged for the benefit of members residing in the New York district. A number have expressed their desire to make the trip by automobile and the Institute's secretary, Dr. J. C. Olsen of Brooklyn Polytechnic Institute, is arranging to organize these into special parties to follow a definite route and schedule.

The principal features of the detailed program follow:

MONDAY, JUNE 19

Meeting at Hotel Clifton

Registration.

9:30 a.m. Papers:

"Thermal Considerations in Sulphuric Acid Concentration," F. C. Zeisberg.

"Modern Methods of Concentrating Sulphuric Acid, Including Concentration of Sludge Acid and Acid Proof Masonry Construction," P. S. Gilchrist.

"Increased Capacity of Cascade Systems," Dr. L. A. Thiele.

"The Solubility of Quartz Packing in the Glover Tower," L. J. Michael and J. R. Withrow.

"Sulphur Dioxide and Fume Problems and Their Solutions," Dr. P. J. O'Gara.

2:15 p.m. Automobile trip, Niagara Falls, Ont., including new power canal and inspection of Niagara Falls plant of Hydro-electric Commission.

8 p.m. Public Lectures, Hotel Clifton:

"Geology of the Niagara District," John Jackson.

"Niagara Power Development" (illustrated), John L. Harper, chief engineer Niagara Falls Power Co.

TUESDAY, JUNE 20

Special cars leave for Lewiston at 9:30 a.m. via the Gorge route on the American side. The boat is taken for Toronto at 10:30 and after business session and luncheon aboard, the party disembarks at 1 p.m. and the afternoon is spent in sightseeing and plant visits. The return boat leaves Toronto at 5:25.

WEDNESDAY, JUNE 21

8:30 a.m. Special cars for Buffalo leaving Hotel Clifton.

9:45 a.m. Meeting at Hotel Lafayette: Papers:

"Manufacture of Nitric Acid," Arthur Hough.

"Manufacture of Hydrogen and Nitrogen for Synthetic Ammonia Manufacture," H. S. Taylor.

"Some Economic Aspects of Ammonia Oxidation," Dr. G. B. Taylor.

"Muriatic Acid—Saltcake Industry," P. C. Kingsbury.

"Vapor Tension at Low Temperatures," N. T. Bacon.

2:15 p.m. Automobile trip and visits to Buffalo plants.

8 p.m. Smoker, Hotel Lafayette.

THURSDAY, JUNE 22

9:30 a.m. Meeting at Hotel Clifton. Papers:

"Production of Hydrochloric Acid for Chlorine and Hydrogen," Hugh Kelsea Moore.

"Tank Cars for Transportation of Muriatic Acid," J. M. Rowland.

"Manufacture of Phosphoric Acid," Dr. P. E. Landolt.

"Manufacture of Phosphoric Acid," Theodore Swann.

"Recent Advances in the Production of Phosphoric Acid for Fertilizer and Food Purposes," W. H. Waggaman.

"Value of Water-Soluble Phosphates," Milton Whitney.

Automobile trip at 2:15 p.m. and optional visits to plants at Niagara Falls, N. Y., followed by a complimentary tea at the Niagara Falls Country Club.

Explosibility of Synthetic Ammonium Nitrate Subject of Study by Bureau of Mines

Upon the recommendation of the committee on the investigation of the explosibility of ammonium compounds of the National Research Council, the Bureau of Mines will undertake an investigation of the explosibility of synthetic ammonium nitrate by boosters on small scale. The work of the committee has for its general purpose the investigation of the explosibility of ammonium compounds, but the Bureau of Mines portion of this, as now proposed, is limited to (*a*) small-scale tests with charges not to exceed 10 lb.; (*b*) that particular ammonium compound designated ammonium nitrate; (*c*) that particular ammonium nitrate which is customarily transported and stored as such outside of powder factories—that is to say, imported synthetic ammonium nitrate. This new investigation is to be conducted on samples at normal temperature, at normal density and a definite but as yet unstated confinement, and the criterion of explosibility is to be the compression of small lead blocks.

Butterworth-Judson Receivers Organize

Receivers for the Butterworth-Judson Corporation, manufacturer of chemicals and dyestuffs, with a plant at Newark, met on April 24 at the offices of the company, 30 Church St., New York City. They are Thomas G. Haight and Henry G. Atha, Newark, and James O'Grady, Scarsdale, N. Y. No statement was given out after the meeting, but it is understood that a plan will be worked out later for carrying on the business of the firm.

Tariff Discussion Opens in Senate—Opposition to Dye Embargo

Discussion of the tariff bill has occupied most of the time of the Senate since April 20. The leaders of each party have outlined the general course their arguments will take. With a couple of exceptions specific rates have not yet entered into the debates.

Initial discussion of the tariff bill in the Senate reveals that there is practical unanimity of opinion in that body that the ad valorem rates in the bill should be based on a valuation made in the country of origin. Sentiment in the Senate seems to be as strongly opposed to American valuation as that of the House is in favor of it. Approximately 60 per cent of the commodities covered by the dutiable list take ad valorem rates. The remainder of the articles on the dutiable list are covered by specific rates. Every effort was made by the Finance Committee to apply specific rates wherever possible. The difficulty is that specific rates are impracticable in many cases.

Many Senators are in favor of passing over American valuation without dignifying it by discussing the plan in the Senate. It seems probable, however, that it will be necessary to debate the whole subject, as the bill reported to the Senate provides for the application of American valuation if the President should deem it necessary.

Chairman McCumber, of the Finance Committee of the Senate, agrees that of all times in our history this is the very worst to formulate and put into effect a new tariff measure, but he declares there never has been a time when it is more necessary to protect American industry against abnormal situations abroad which give special advantage to the foreign producer. He points out that wages in Germany declined enormously immediately following the armistice. In the other countries, he said, measured by the only stable currency in the world, the American dollar, the spread between American cost of production and foreign cost of production has been growing greater and greater. On the other hand, costs of production increased in this country until January, 1921.

Comparisons between the present bill and the Underwood act or the Payne-Aldrich law are of little value, in the opinion of Senator McCumber. He declares his committee gave but casual attention to either of these acts. The whole industrial, commercial and economic world has changed since those bills were enacted, he contends.

Sees Tariff Commission More Powerful

Under the bill as amended by the Finance Committee, Senator McCumber expects to see the Tariff Commission become a forum in which any complaints may be lodged as to the unfairness or the injustice of any rate. With the powers given the President, it will be possible to rectify any injustice caused by rapidly changing conditions.

On April 24 Senator Smoot addressed the Senate at length on the bill. He pointed out that tariff making is becoming more and more intricate with the progress of invention and the development of American industry. He referred to the fact that the tariff of 1890, including the free list and omitting all administrative regulations, covered only 47 pages of the size on which the bill is printed. The act of 1909 covered 71 pages, while the present bill covers 85 pages of the same size. He predicted that tariff making will continue to take more and more of the time of the legislative branch if the present method of procedure continues to be followed. If Congress is to have time for other legislative duties, he points out that it will be necessary to delegate a certain portion of the work to executive and administrative agencies. He thinks business interests will welcome any change in the tariff policy which will render less frequent and less violent the upheavals incident to tariff revision.

Believes American Valuation Impractical

The Utah Senator pointed out that under world conditions as they exist today it will be absolutely necessary to make frequent modifications of rates if the tariff is to be equitable to producer and consumer alike and does not burden unnecessarily our foreign trade. He attempted to show that American valuation would be unworkable. He said the research of the Senate committee had demonstrated that relatively few products having the same generic name as domestic articles are sufficiently similar to permit of price comparisons. The trade mark on most goods, he declared, has almost as much to do with their value as have their physical qualities. He cited specific examples to show that 28 per cent ad valorem, the American valuation equivalent of 60 per cent on foreign value, would result in American valuations varying from 164 to 297 per cent. One of the chief objections, in Senator Smoot's opinion, to adopting the American selling price of the imported article as a basis for the assessment of duty lies in the fact that an importer will reduce the selling price of any particular article which he desires to make closely competitive with a comparable domestic article. It is such articles which are used by merchants as leaders, sold at a very small marginal profit and sometimes under cost to attract trade likely to purchase other articles in his stock. American valuation permits the importer to sell his leader below the average level upon which the American valuation equivalent rate of duty necessarily would have to be based.

Senator Smoot said the Reynolds investigation, made for the Committee on Finance by the Treasury Department at a cost of $100,000, revealed conclusively the wide fluctuation in importers' margins and demonstrated that imported articles in the American market fluctuate more widely than does the value of these articles in their home markets. The Senate rates, he contends, offer greater security to the American manufacturer than equivalent rates based on American values. Nothing could be more disturbing to business, in the opinion of Senator Smoot, than a revolutionary change in the basis of valuation.

Will Oppose Dye Embargo

In his initial speech on the tariff, Senator Smoot indicated clearly that he would be active in his opposition to the dye embargo provision added to the bill by the Senate committee. He declared that the embargo may have had its justification in the period immediately following the armistice, but he believes it to be unnecessary to incorporate the plan in a permanent tariff bill. He said it is inevitable that the weaker coal-tar chemical industries will be eliminated anyway in competition with the stronger domestic concerns, and that the embargo will do little to help them and will place an unnecessary burden on the dye-consuming industries.

One of the important aims of the Senate committee's bill, Senator Smoot said, is to apply one tariff to all countries alike, and force all countries to give American products equal treatment with those accorded to other countries.

Basis of Democratic Opposition

Senator Simmons of North Carolina, the ranking Democrat on the Finance Committee, declared that the bill is based on three erroneous assumptions. One is that present importations are excessive and a menace to the business of the country. The second, he says, is the assumption that the home selling price and the export selling price of foreign merchandise are so much lower than the selling price of comparable domestic products that higher rates of duties are needed to bring about fair competitive conditions. He also branded as unsound the deductions from the Reynolds report. The report, he said, was based on selling prices in August, 1921. The committee, he asserts, has assumed that price levels have not changed since that date. He charges that the bill will cause higher prices, will add materially to the cost of living and will permit further monopolization of American industries. The rates in the Senate bill, he declared, are 40 to 50 per cent higher than the average Payne-Aldrich rates when the difference of price levels between that period and the present are taken into consideration. The current volume of imports, he declared, is not excessive and is relatively small when compared with the volume of our exports. Among the other points he made against the bill was the need for expanding foreign markets so as to absorb our surplus production from the field, the factory and the mine. If our surplus capacity is not utilized, he argued, the amount of unemployment will increase.

Crystallizing Sentiment on Muscle Shoals Presages Rejection of All Offers

Disinterested opinion on Capitol Hill is to the effect that no one of the Muscle Shoals offers will be accepted. It is believed the government will reopen work on the dam and will complete it, after which leases will be made for the disposal of the power.

A sub-committee of the Committee on Military Affairs of the House has made a formal report to the effect that no offer will be considered which does not conform to certain fundamentals. The first essential is that the property be subject to requisition at any time by the government for the production of war materials, and that Nitrate Plant No. 2 be kept in such condition as to be capable of producing nitrates at any time. Another condition, held by the sub-committee to be fundamental, is that a definite contract be entered into for the manufacture and sale to the public of a fixed quantity of mixed fertilizer. A third condition is that any deal must be made for the entire property with the exception of the steam plant at Gorgas and the transmission lines connecting it with Plant No. 2.

The Military Affairs Committee is discussing the proposition in executive session. All offers except that of Henry Ford have been tabled. The Ford offer, at this writing, is being read paragraph by paragraph. The committee expects to make its final report during the first week in May.

Senate Considers Engstrum Offer

The Senate Committee on Agriculture heard former Senator Marion Butler at great length on the Engstrum proposal for Muscle Shoals. Among other things, he said:

"Here we have two nitrate plants and two steam power plants, and the greatest hydro-electric dam in the world partly completed, which has cost the government $106,000,000. The act of Congress appropriating this money declares that it should be used to produce nitrates from the air for explosives and also for fertilizers. We produced nitrates there during the war by use of steam power; but we could not produce sufficient nitrates both for explosives and for fertilizers, therefore agriculture starved for want of nitrogen during the war.

"When the war was over, we stopped these nitrate plants, and we stopped work on the hydro-electric dam. We should correct that mistake at the earliest possible moment; with that dam finished, we could now be producing the cheapest nitrates for fertilizers in the world, but we could not even then produce as much nitrogen as is now needed for fertilizers alone until we build more nitrate plants.

"Under these serious conditions, it would be nothing less than a crime to abandon this great nitrogen project at Muscle Shoals. It will be as bad in principle and almost as bad in results to lease or sell this Muscle Shoals project to parties who will use only one-tenth of that great power to produce nitrogen while nine-tenths of it will be used for making automobiles, aluminum, etc., for private profit.

Would Utilize All Water Power for Nitrates

"The duty of Congress is plain; we should go forward and utilize this great investment and great water power to serve the public good. We should, at once, finish dam No. 2 and put both of these nitrate plants to work, day and night; we should then build dam No. 3 and put up another nitrate plant by its side. Indeed, we should go forward and develop the whole one million horsepower on that river, and use it all to make cheap nitrates for fertilizers."

Commenting on the published statement of Secretary Wallace that the War Department surplus ammonium nitrate was not being bought by fertilizer manufacturers and calling attention to the availability of Chilean saltpeter for this use, Mr. Butler said that these statements are absolutely true, but without explanation would cause misapprehension. He said that ammonium nitrate, offered for sale by the government, is not suitable for fertilizer. The imported sodium salt, on the other hand, is so expensive that the farmer is not using half the fertilizer the soil needs.

In conclusion Mr. Butler appealed to Congress either to go ahead with Muscle Shoals as a government enterprise, as provided in the national defense act, or to lease it under a contract which will produce the largest output of cheap nitrates for fertilizers as proposed by the Engstrum company.

R. R. Grant, president of the American Non-Ferrous Corporation and the Aluminum Wheel Co. of America, is conferring with War Department officials on a plan whereby the companies would take over on a 25-year contract the Muscle Shoals nitrate plant, for production of aluminum and fertilizer.

Ford Wants Gorgas Plant

Henry Ford insists that the government's equity in the steam plant at Gorgas on the Warrior River and the transmission line to Plant No. 2 be included in the property which he proposes to lease. W. B. Mayo, chief engineer for Mr. Ford, gave this message to the members of the Military Affairs Committee on April 27, when he appeared before the committee in executive session.

The committee has made up its mind quite definitely that the government should not lease the Gorgas plant and transmission line at this time. The action of Mr. Ford in demanding that these items be included in the list of property which he wishes to lease came as a surprise to the committee, a majority of which appears willing to recommend the acceptance of Mr. Ford's offer, provided it is amended in certain important particulars.

Chicago Section, A.C.S., Elects Officers—Papers on Yeast and Temperature Control

Synthetic nutrient mediums for yeast culture were discussed before the Chicago Section, American Chemical Society, on Friday evening, April 21, by Prof. Ellis I. Fulmer of the department of agricultural chemistry, Iowa State University. The effect of varying the amount of each of the following components was carefully studied: NH_4Cl, K_2HPO_4, $MgSO_4$, $CaCO_3$ and cane sugar. Points of optimum concentration were found in some cases, notably ammonium chloride and calcium carbonate, which explain conflicting results reported previously. As a result of this work, yeast has been grown continuously for 2 years by subculturing in a medium containing only K_2HPO_4, NH_4Cl and sugar.

At the group meeting on synthesis, R. C. Shuey of the Redmanol Chemical Products Co. described the methods used for controlling the temperature during the various steps in the manufacture of synthetic resins. The reactions are exothermic and very careful regulation is essential in order to keep a batch from getting beyond control. A system comprising a thermocouple element operating a small compressed air valve which in turn controls the movement of the main valve was found very satisfactory in regulating steam-heated stills where the pressure in the steam line was kept practically constant.

Officers were elected as follows: Chairman, C. S. Miner; first vice-chairman, P. N. Leech; second vice-chairman, E. S. Weirick; secretary, S. L. Redman; treasurer, O. N. Berndt; editor of the *Chemical Bulletin*, E. H. Volwiler; trustee, W. Lee Lewis; councilors, D. K. French, H. N. McCoy, L. V. Redman, W. R. Smith, Ethel M. Terry, L. M. Tolman, Paul Van Cleef, G. L. Wendt, F. C. Whitmore; Willard Gibbs jurors, Lauder W. Jones, W. Lee Lewis, H. N. McCoy, J. H. Mathews.

Immigration Bars Hinder Erection of German Briquetting Machinery

Half a million dollars worth of German briquet-making machinery, contracted for to be used in connection with the lignite deposits in Victoria, Australia, may have to be refused, since under the Australian immigration act of 1920, Germans are prohibited for a time from entering the country and the two experts who were to have put up the machinery are being kept out. The question is being actively discussed, and references have been made as to the possibility of obtaining similar machinery in the United States to take the place of the German machinery, or else to employ Americans to erect the German machinery.

Information Desired on Standard Analytical Methods

American Engineering Standards Committee, 29 West 39th St., New York City, would be glad to hear from chemists who are using the A.S.T.M. Standard Methods for Chemical Analysis of Tin, Antimony and Copper, and their methods for laboratory sampling and analysis of coke, as to the extent the specifications are used, and any comment on their usefulness. These are proposed as "Tentative American Standards."

Dye Hearings About to Close—Developments of Past Week

Hearings before the sub-committee conducting the dye investigation were virtually brought to a close last week. This was the outstanding development of the week, although a touch of light drama was injected by the National Association of Hosiery and Underwear Manufacturers when their counsel was interrupted in the midst of his testimony and told that his clients had suddenly decided not to play any more. As far as Senator King's monopoly charges are concerned, it seems pretty generally accepted that the industry has shown a clean bill of health and the only mention made of monopoly during the testimony were the occasional references which seemed necessary to entitle the speakers to the floor before such a committee.

The sub-committee plans to hear Paul Pickhardt of Kuttroff, Pickhardt & Co. and representatives of the Chemical Warfare Service this week. Senator Shortridge announced that every opportunity would be given to anyone believing he has additional evidence of importance to present it. He also announced that the sub-committee will discuss the reparation dyes situation with Secretary Hughes some time this week.

Socks and Shirts—A Comedy in Three Acts

The first appearance of representatives of the National Association of Hosiery and Underwear Manufacturers was on March 11, when George Demming, a lawyer, of Philadelphia, handed Senator Shortridge a letter violently attacking the conduct of the dye investigation, after which he promptly disappeared. The letter purported to express the sentiment of the association, and was quite caustic in its criticism of the sub-committee's methods. Shortly afterward John N. McCullaugh, consulting industrial manager for the association, denied authorship of the letter and asked that it be stricken from the record.

The second act opened on April 20, with Mr. McCullaugh testifying as to Mr. Demming's unquestioned right to speak for the association in testimony before the sub-committee. He stated that Mr. Demming was appointed special counsel for the association and was authorized to appear for it by authority of the board of directors.

The third act is laid at the next meeting of the sub-committee 5 days later. Mr. Demming's testimony was suddenly and dramatically interrupted by Mr. McCullaugh, accompanied by Joseph Rambo of Philadelphia, one of the board of governors of the association, who declared that by authority of a majority of the board of directors of the association he wished to withdraw Mr. Demming as its representative and to withdraw his evidence as far as the association was concerned.

Both Mr. Demming and Senator Shortridge expressed surprise at this action. Mr. McCullaugh explained the changed attitude by saying that a majority of the board of directors had decided that "we have our own hands full with our own business" and did not wish to interfere in the hearing.

Hosiery Company Supports Embargo

Senator Shortridge read a telegram from John Fitzgibbon, manager of the Phoenix Knitting Works, Milwaukee, Wis. The text of the telegram follows:

> We have noticed George Demming's opposition before your committee to selective embargo protection for American dye manufacturers. As one of the largest hosiery manufacturers of the country and also a member of the National Association of Hosiery and Underwear Manufacturers, we entirely indorse a selective embargo as applied to dyestuffs. We strongly urge you and your associates to give adequate protection to American dyestuffs manufacturers to enable this industry to continue successfully. We buy substantial quantities of American dyestuffs for our plants and find American manufacturers are manufacturing dyes of equal quality with the German products at reasonable and continually decreasing prices and that cost of American dyes is no hardship to us.

Isermann Testifies Again

Representing the small dye manufacturer, Samuel Isermann, with statistics at his fingertips and keenly aware of the facts, added to his previous testimony as to the value of the embargo and the competition among domestic producers. The selective embargo has smashed the German grip on dyes and other coal-tar products, he said. The results have been of incalculable value to American consumers, for when it swept away the monopolistic control here of German manufacturers the exorbitant prices charged for many products were likewise broken. Dr. Isermann cited examples in perfumes and drugs, showing how American manufacturers had brought down exorbitant German prices.

The witness then attacked the testimony of H. A. Metz, in which the latter stated that his manufacturing interests are greater than his importing interests. Dr. Isermann also made a detailed attack on the testimony of E. R. Pickrell, of Mr. Metz's staff, and criticized the testimony of Ward Thoron, of the Merrimack Manufacturing Co., who based much of his testimony on the term "drugs," which, as Dr. Isermann pointed out, included many things in addition to dyestuffs.

The Small Producer and American Monopoly

Dr. Isermann emphasized the great strides made by American dye manufacturers since the war and pointed out the importance of the small manufacturer in developing the processes. He recounted briefly the reasons set forth by previous witnesses showing why more than a tariff is needed to protect the American industry, and then took up in more detail the problem of substitution.

Less than a thousand different dyes were imported into the United States prior to the war, he said. But for each one of these dyes imported there were satisfactory substitutes which would produce substantially the same results when used in substantially the same manner, and the German chemical industry knew how to make them. If a tariff was written for the protection of one American dye the German producers could simply turn to a substitute product not specified in the tariff law, he said.

There is quite a danger that large concerns by cutting prices will force the smaller companies out of business, and it has been suggested that in course of time there might be a tendency to form a monopoly. There is a possibility that this could take place, but competition today is keen.

Metal Failures Discussed by Steel Men

"The Influence of Quality From the Standpoint of Workmanship and Material" was the title of the address by Frank P. Gilligan, president of the American Society for Steel Treating, before the Washington chapter of that organization on Friday, April 21. Mr. Gilligan, who is the vice-president of the Henry Souther Engineering Co., of Hartford, Conn., discussed his general subject broadly, but gave particular attention to the question of metal failures, which he and his engineering organization have investigated thoroughly. The importance of quality in relationship to metal performance was emphasized.

King Would Investigate Alien Property Activities

Senator King of Utah has introduced a resolution for an investigation by a committee of five Senators of various activities of the Alien Property Custodian, including the sale of patents, trade marks and trade names to the Chemical Foundation, or others.

American Institute of Chemical Engineers to Hold Conference on Chemical Engineering Education

The American Institute of Chemical Engineers is arranging for a conference on the report of its committee on chemical engineering education presented at the Baltimore meeting. Invitations have been sent to the presidents of eighty-three universities and technical schools which offer courses in chemical engineering to attend or send representatives to the conference for discussion of the report. A printed copy of the report was sent with the invitations. The conference will be held on May 16 at the Brooklyn Polytechnic Institute, sessions being held at 10 a.m. and 2:30 p.m. and also at 8 p.m. if necessary.

A preliminary report of the findings of this committee was presented at the Detroit meeting of the Institute and was published in CHEMICAL & METALLURGICAL ENGINEERING, vol. 24, No. 24, pp. 1047-53, June 15, 1921.

Power Test Codes Committee Completes Three Codes to Be Discussed at A.S.M.E. Meeting

On Tuesday morning, May 9, of the spring meeting of the American Society of Mechanical Engineers in Atlanta, Ga., a public hearing is set for the discussion of the three additional power test codes which have reached this stage in their development during the past year. Last May at Chicago this committee, of which Fred R. Low, editor of *Power*, is chairman, presented codes on general instructions, steam engines and evaporation apparatus. It now presents codes on definitions and values, displacement compressors and blowers, and hydraulic power plants, all three of which have appeared in *Mechanical Engineering*.

Though these codes have passed through six successive revisions in reaching their present form, the committee will welcome a full and frank discussion by the members of the society and others interested. Members not planning to attend the spring meeting and others are invited to prepare written discussions.

Reprints of all three codes revised to date have been prepared by the committee and may be obtained by addressing C. B. LePage, secretary to the committee, at the society's headquarters.

In 1918 the power test codes committee of the A.S.M.E. was reorganized to revise and enlarge the power test codes of the society, published in 1915. The committee is a large one, consisting of a main committee of twenty-five under the chairmanship of Fred R. Low, and nineteen individual committees of specialists who are drafting codes for the different classes of apparatus comprised in power-plant equipment.

Symposium on Glycerine and the Fatty Acids

An extremely practical treatment from the industrial standpoint featured the symposium on glycerine and the fatty acids held at a joint meeting of the Society of Chemical Industry, American Chemical Society, American Electrochemical Society and the Société de Chemie Industrielle at the Chemists' Club, New York, April 21.

J. W. Bodman, of William Garrigue & Co., gave a very interesting talk on the distillation of glycerine from the standpoint of a chemical engineer. The talk was profusely illustrated with slides showing details of the apparatus and process. The distillation of glycerine is essentially an application of the principle of a double effect vacuum evaporator. In the manufacture of dynamite glycerine, the apparatus used consists essentially of an evaporator, two condensers known as the superheater and cooler, and a concentrator. The steam used in the concentrator is obtained from the evaporator, and the sensible heat in the vapors as well as the latent heat of evaporation of the glycerine is used in the heat interchangers.

It would be possible to condense all the glycerine in the first condenser, but in practice a certain amount is permitted to go through to the second condenser, as otherwise some of the lower fatty acids would condense out with the glycerine. The construction details of the tubular copper condensers and of the ingenious catch-all, which throws out some of the salt between the still and superheater, were shown.

In the manufacture of pure glycerine, the first distillate is diluted, treated with lime, filtered and redistilled. The yield of the operation depends upon the disposal of the "foots." In good operation about 94 per cent of dynamite glycerine is obtained, with 4 per cent in the "foots" and 1.9 per cent in the "sweet water." Mr. Bodman pointed out the saving accomplished by the utilization of the latent heat of vaporization of glycerine.

Passing to the subject of the distillation of fatty acids, Mr. Bodman described the commercial process and gave some interesting figures on the fatty acid and glycerine yields from stocks from different sources.

R. C. Farra, of the Standard Textile Products Co., Passaic, N. J., described the modern method of manufacture of oilcloth, describing the qualities desired in the fabric, the calendering process which precedes coating and the preparation and coating of the "daub." The oil is boiled for 2 hours at about 600 deg. F., some oxide of lead, iron or manganese having been added to aid the oxidation. These so-called driers also prevent the "separation" of the oil. The oil is cooked to a standard viscosity and mixed with china clay. Alkali, usually ammonia, is added, giving a water in oil emulsion. A solution of casein or other sizing is added, giving an oil in water emulsion, which can be thinned to proper consistency with water. The fabric is coated and surface dried for 5 minutes, when the second coat may be applied. Final drying is carried out in a festoon drier for about 8 hours at 130 deg. F. The pigment used for white oilcloth is zinc oxide and for black oilcloth is carbon black. The glazing operation was described and several promising lines of research were suggested.

A. C. Langmuir discussed the need for a standard method of evaluating glycerine.

American Ceramic Society Plans Summer Trip to England and Europe

In response to an invitation extended last year by the British Society of Glass Technology, the American Ceramic Society is making arrangements for a party to sail from New York on the Cunard liner Aquitania, Aug. 22.

With regard to the reception of members interested in things other than glass, Dr. Turner writes that the refractories group surely will be welcome. While negotiations are still pending for the other groups, there have been no definitely unfavorable reports.

Dr. Turner has in charge the arranging of the tour of England, which will require about 3 weeks after arrival in England. Special trips will be arranged for the several groups representing the divisions of the society. Those wishing to visit the Continent will be expected to make their own arrangements, since no organized visit will be made.

All members interested are urged to communicate at once with Dr. E. Ward Tillotson, Mellon Institute, Pittsburgh, Pa.

American Leather Chemists Association to Hold Summer Meeting in Canada

Bigwin Inn, delightfully situated in the Lake of Bays district, Ontario, Canada, has been chosen for the nineteenth annual meeting of the American Leather Chemists Association, June 21 to 23. In addition to the usual committee reports, special addresses of interest to the tanner as well as the chemist are being arranged. Prof. F. E. Lloyd of the department of botany, McGill University, will speak on "The Mode of Occurrence of Tannin in the Living Cell." Several papers will be contributed from the Leather Research Laboratory of the Tanners' Council in the University of Cincinnati. Titles of two of the papers have been announced by Prof. McLaughlin—"Bacteriology of the Fresh Hide" and "The Science of Curing." Further details will be given as they assume definite form.

The association is particularly desirous of having the practical men of the industry well represented at the meeting, it being felt that there will be much of interest to them on the program.

Domestic Potash Producers Encouraged by Tariff Prospects—Operations Resumed

Domestic producers of potash are much pleased with the action of the Finance Committee of the Senate in approving the potash paragraph put into the tariff bill by the House. Commenting on this action, Frederick W. Brown, the executive secretary of the United States Potash Producers' Association, says:

"No industry ever presented a fairer proposal in seeking protection. A study of the potash situation is all that is necessary to reveal the justice of the American producers' request for a diminishing scale of duties. The industry should be protected, not only that we may be insured an increasing production of domestic potash but in the interest of the farmer himself.

"With the indorsement of the committee, only one step remains to be taken—the passage of the item by the Senate—to free America from the foreign potash monopoly."

Operations Resumed at Searles Lake

The American Trona Corporation resumed operations at Searles Lake April 10, with expectations of reaching a record production of potash and borax in the near future. With the exception of an installation of new condensers, no change has been made in the operations or equipment since the shut-down. The company plans to apply the results of recent research to the production of several new byproducts as soon as practicable.

"Informashow" Planned in Connection With Rochester Meeting of Purchasing Agents

An "Informashow," an industrial exhibition with a new idea behind it, is scheduled in Rochester, May 15 to 20, in connection with the convention of the National Purchasing Agents' Association which is to be held there at that time.

The consideration which chiefly influences the purchasing agent is value, which comprises service, quality and favorable price. These considerations sum up the benefits that the corporation will derive as a result of the purchase. Consequently, any exposition that shows the value of equipment should be of value to purchasing agents. The "Informashow" is designed as a medium for demonstrating the value of various industrial equipment, and to furnish an opportunity for the seller to inform others of the value of his product and for the purchaser to learn. With this principle in mind, every effort has been made to include exhibits which demonstrate the value and uses rather than the products themselves. About 100 exhibitors have reserved space. It is expected that about 1,200 purchasing agents will be present.

Minerals Separation Suits Closed by Settlement

On April 28 the negotiations which have been in progress during the last 4 or 5 weeks between the Minerals Separation and the Jackling interests and also the Miami Copper Co. terminated in a settlement satisfactory to all parties. This settlement will, therefore, terminate the hearings before the masters in the Butte & Superior case and the Miami Copper Co. case, as well as the cases pending in courts against all the mines of the Jackling interests.

Personal

W. H. Alger of Orange, Va., has been elected president of the Amelia Mica Mining & Developing Co., Chula (Amelia County), Va. W. W. Alger has been elected vice-president and R. B. Roberts secretary and treasurer.

Dr. Hugh P. Baker, executive secretary of the American Paper and Pulp Association, will spend 8 weeks in Europe this summer studying conditions in the paper industry in Norway, Sweden, Finland, Germany, Austria, Poland and Czechoslovakia. The Department of Commerce is particularly interested in the effect on the paper industry here and abroad of the establishment of the new European republics and the revision of boundaries. Dr. Baker will bear a special commission to study this phase for the department.

J. W. Bostwick has been appointed general manager of the Kansas & Gulf Oil Corporation, with headquarters at Tulsa, Okla.

H. C. George, of the petroleum division of the Bureau of Mines, is en route to Alaska.

Prof. W. D. Harkins of the University of Chicago addressed the Franklin Institute in Philadelphia on April 19, taking for his subject "The Structure and Building of Atomic Nuclei."

F. M. Harrison, president of the U. S. Industrial Alcohol Co., New York, has resigned. He will be succeeded by H. S. Rubens, chairman of the board of directors, who will continue also in the latter capacity.

The partnership of Huntoon & VanArsdale has been discontinued. L. D. Huntoon will continue practice as consulting mining engineer at 115 Broadway, New York City, and G. D. VanArsdale will continue practice as consulting chemist and metallurgist at 1011 South Figueroa St., Los Angeles, Cal.

Dr. Irving Langmuir of the General Electric Co. spoke before the Delaware Section of the American Chemical Society in Wilmington on April 19 on "Molecular Structure and Its Relation to Chemical Valence."

Charles A. May, president of the Maddock Pottery Co., Trenton, N. J., was the guest of honor at the tenth anniversary banquet celebration of the local Federal Club, April 18.

Prof. Alan C. W. Menzies of Princeton University addressed the Philadelphia Section of the American Chemical Society on April 20, on "Modern Study of the Atom."

C. Wilbur Miller, president of the Davison Chemical Corporation, Baltimore, Md., plans to sail for Europe May 16, for business and pleasure, and will be absent for a number of weeks.

H. O'Connell of Plattsburg, N. Y., has been engaged by the Dexter Sulphite Pulp & Paper Co. of Dexter, N. Y., as chemist in charge of the chemical laboratory and experimental station.

Edgar S. Ross, formerly chief chemist for the Charlotte Chemical Laboratories and Columbite Reduction Co. of Charlotte, N. C., and for the past several years engaged in private research concerning the metals tantalum and columbium, is now chemist and assistant manager for McKechnie Bros., Inc., metal smelter and refiner of Philadelphia, Pa.

Kenneth D. Tucker, connected with Magnus, Mabee & Reynard, New York, manufacturers of essential oils, and previously associated with the essential oil department of the National Aniline & Chemical Co., resigned May 1, to engage in business with his father.

Obituary

Sir John Benn, known in England as the "father" of the London County Council, and chairman of the board of Benn Bros., Ltd., the largest publisher of technical and trade papers in Great Britian, died in London, April 10. He entered the field of business journalism in 1880, when he established the *Cabinet Maker*, devoted to the furniture trade. The venture succeeded and in time the business expanded until at his death the firm was publishing thirteen business journals, including the *Chemical Age*, the *Electrician* and the *Gas World*.

George C. Ripley, superintendent of the Electrolytic Zinc Refinery of the Anaconda Copper Mining Co. at Great Falls, Mont., died on April 17, 1922, of pneumonia. He graduated from the Colorado School of Mines in 1906, then spent about 10 years in China and the Philippines. Returning to the United States, he joined the operating staff at Great Falls shortly after the electrolytic zinc department started operations.

Market Conditions

IN CHEMICAL, METALLURGICAL AND ALLIED INDUSTRIES

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities—Prevailing Prices and Market Letters From Principal Industrial Centers

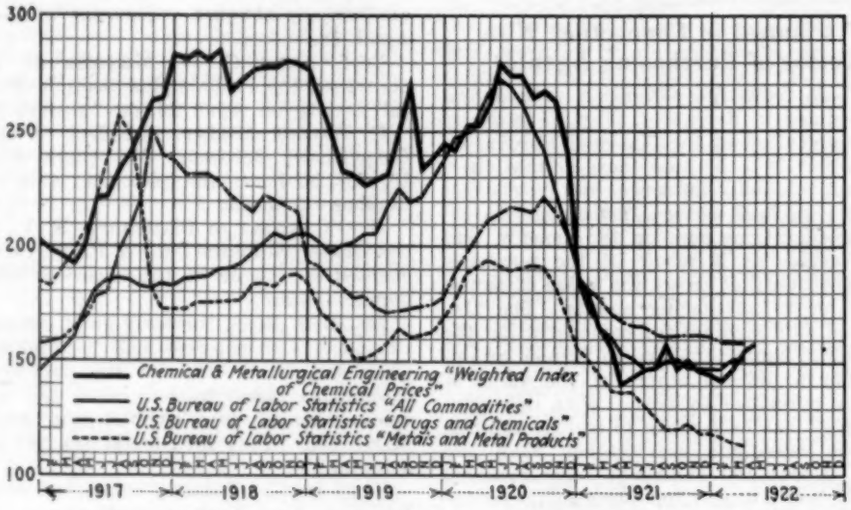
April's Progress Toward Better Business

Continued progress was made during April in the return to that mythical state of business which we sometimes call "normalcy." That term, to be sure, is capable of many interpretations and to the individual manufacturer it is likely to mean the particular time at which his own plant was running at its maximum capacity. Normalcy so defined may never be reached again, but certainly there is much in the fundamental economic situation to indicate that better business is definitely ahead.

Many powerful factors are making for an industrial betterment that cannot be accounted for strictly by seasonal influences. Of these factors, four are outstanding at the present time: (1) A larger volume of manufacture is evident in many of the basic industries. (2) Increases in wholesale prices are gradually predominating over the decreases. (3) There has been a noticeable easing up of money rates which has directly or indirectly resulted in (4) sustained strength and unusual activity in the stock and security markets. The most prominent gains in production are probably in the iron and steel industries. In the face of firm and even advancing prices, steel production has increased until present operations are in the neighborhood of 75 per cent of capacity as compared with 40 per cent at the beginning of the year. This rate approximates that for the year 1913. The monthly output of steel ingots in March (2,370,751 tons) was better than at any time since November, 1920. Pig-iron production during April was said to be larger than for any month since January, 1921.

In other basic industries, especially paper, petroleum products and certain of the heavy chemicals, there has been a moderate increase in manufacturing output. Probably some little gain in freight movement of general commodities has occurred, although car loadings, the usual index of this movement, have fallen off somewhat during April. This has been due largely to the coal strike and the feverish activity which preceded it. For example, car loadings during the week ended April 8 were 714,268 cars, as compared with 827,011 during the previous week, a reduction of 112,743 cars. Coal loadings for the same week in April totaled 69,456, a decrease as compared with the week before of 115,496 cars.

The activity in the stock market which has been noted in our earlier reports continued without interruption during April. Toward the end of the month there were occasional tendencies toward reaction and a rather general feeling that the peak has been reached in the present upward movement. The *Annalist's* average of twenty-five industrials, which stood at 73.0 on Aug. 1, 1921, had mounted to 92.9 by April 1 and ended the month at 96.6. A similar gain had been shown in CHEM. & MET.'s average of the stocks of twenty representative companies in the chemical and allied industries, which rose from 46.1 on Aug. 1, 1921 to 63.8 on May 1, 1922. A comparison between the low figures of 1921 and the recent high for certain chemical, metallurgical and related industrials gives a definite idea of the extent of this appreciation. The approximate gains in actual dollars based on the outstanding stock issues have been calculated by W. J. Wollman & Co. and are shown in Table I.



THE UPWARD TREND IN CHEMICAL PRICES SINCE JANUARY, 1922

One of the factors of potential importance is the coal strike, although its effect has not, and perhaps may not, be felt by industry in general. The recent rise in iron and steel prices has been attributed in part to the trouble in the coal fields, but certainly there were other factors of more serious import. About the only element of surprise in the situation has been the larger number of non-union

CHEMICAL & METALLURGICAL ENGINEERING'S WEIGHTED INDEX OF CHEMICAL PRICES

Base = 100 for the year July 1, 1913, to June 30, 1914

This week	158.41
Last week	158.27
May, 1917	222
May, 1920	279
April, 1918 (high)	286
April, 1921 (low)	140

This index number is based on the wholesale prices in the New York market for acetic acid, citric acid, hydrochloric acid, nitric acid, sulphuric acid, ethyl alcohol, methanol, anhydrous ammonia, ammonium sulphate, barium chloride, bleaching powder, borax, caustic potash, caustic soda, copper sulphate, formaldehyde, glycerine, potassium carbonate, saltcake, soda ash, crude sulphur, benzene, aniline oil, cottonseed oil and linseed oil.

TABLE I—RECENT APPRECIATION IN THE STOCKS OF CERTAIN CHEMICAL, METALLURGICAL AND ALLIED COMPANIES

Stock	Low of 1921	Recent High	Approximate Gain in Dollars
Allied Chemical & Dye Corp.	34	68	$73,763,578
Anaconda Copper Mining Co.	31½	54½	68,250,000
American Smelting & Refining Co.	29½	59½	18,223,152
American Sugar Refinery Co.	47½	74½	12,037,500
Corn Products Refining Co.	59	108	24,394,160
Davison Chemical Co.	23	63	8,000,000
General Asphalt Co.	30½	65½	5,118,958
Mexican Petroleum Co.	84½	135½	21,903,649
U. S. Steel Corp.	70½	99½	147,407,725

miners who have joined the movement. As yet there is no indication of the settlement of the strike, and even when it does come it can scarcely be regarded as a permanent answer to the problem of the bituminous coal industry. The only satisfactory solution will depend upon the elimination of the intermittent operation caused by overcapacity and overproduction.

The foreign exchange market has remained comparatively stable throughout the month, presumably pending the results of the Genoa conference. All of the exchanges have, however, shown slight recoveries from the low levels reached toward the end of March. Sterling rose from $4.37 on April 1 to $4.41⅞ on April 15, and has since maintained this level. German marks, which on March 27 had fallen to $0.0028⅛, the lowest on record, recovered to $0.0035 toward the end of April. French francs rose from 9.09c. on April 1 to 9.26¼c. on April 20.

The continued rise in general wholesale prices during March as indicated by the index numbers of the Bureau of Labor Statistics, were reviewed in last week's issue. These slight gains were probably maintained for most commodities during April, although comparatively few striking advances were recorded. Chemical prices, however, may be regarded as an exception in that higher prices were maintained throughout practically the entire list. CHEM. & MET.'s weighted index of chemical prices averaged 158.04 for the month of April, as compared with 156.19 for March. These are the highest quotations since August, 1921, and show a gain during the last 3 months of approximately 16 points.

Not all the factors in the business situation may be regarded as favorable, and some setbacks are bound to occur, but it may be said with no undue optimism that the industries served by CHEM. & MET. are gradually emerging from the period of depression.

Margarine Production in 1921

The annual report of the Commissioner of Internal Revenue for the fiscal year ended June 30, 1921, gives the following figures for the production of oleomargarine as well as the materials entering into its manufacture. The difference of about 60,000,000 between the total weight of vegetable oils and other materials consumed and the output of finished margarine is due almost entirely to the water content of the milk.

	Lb.
Oleomargarine, produced	281,081,514
Materials consumed:	
Cocoanut oil	103,111,916
Milk	79,715,584
Oleo oil	49,675,749
Neutral oil	29,267,960
Salt	25,365,499
Cottonseed oil	18,532,860
Peanut oil	16,332,498
Vegetable oil	6,559,034
Oleo stearine	4,857,972
Oleo stock	2,065,231
Butter	1,498,625
Corn oil	925,999
Soy bean oil	461,129
Edible tallow	233,227
Mustard seed oil	109,748
Coloring	25,915
Miscellaneous	3,216,742
Total materials	341,955,688

International Paper Shows Loss

Another company to make an unfavorable report for operations in 1921 is the International Paper Co. The net loss for the year before payment of preferred dividends was $7,442,890. Of this amount $6,276,607 was for depreciation of inventory, although at the ordinary rate of depreciation this would amount to only about $2,379,967. The operating profit for the year was $1,542,642 notwithstanding the fact that during May and June the company's mills were shut down on account of a strike.

President Dodge in the report significantly stated that inventory might have to be adjusted either way at the end of 1922. General opinion is that prices of pulpwood have reached bottom and can be expected to move upward later this year when the large buying interests come into the market.

Government Nitrate Sales

Prices obtained for the nitrate of soda recently sold by the government are as follows:

At the Old Hickory Ordnance Reserve Depot, $42.50 per ton; at Middletown Ordnance Reserve Depot, $47; at Nitro, W. Va., $41 and at Morgan General Ordnance Depot, $50 per ton.

The successful bidders were Baugh Chemical Co., Baltimore; Baugh & Sons Co., Baltimore; M. D. Biddeson, National Aniline & Chemical Co., New York; Butterworth-Judson Co., New York; Caraleigh Bros. & Fertilizer Co., Raleigh, N. C.; Egyptian Powder Co., East Alton, Ill.; Equitable Powder Co., East Alton, Ill.; Farmers Fertilizer Works, Elizabethtown, Pa.; Farmers Guano Co., Norfolk, Va.; J. R. Gay, Gay, Ga.; W. R. Grace & Co., New York; General Chemical Co., New York; Granton Chemical Co., New York; Graselli Chemical Co., Cleveland, Ohio; King Powder Co., Cincinnati, Ohio; Lancaster Chemical Co., Lancaster, Pa.; Mahoney & Hoban Chemical Co., New York; John K. McIver, Savannah, Ga.; Read Phosphate Co., Savannah, Ga.; A. F. Pringle, Charleston, S. C.; Senior Powder Co., Cincinnati, Ohio; Southern Agricultural Chemical Corporation, 61 Broadway, New York; Stauffer Chemical Co., Chauncey, N. Y.; Tennessee Copper Co., 61 Broadway, New York; Trojan Powder Co., Allentown, Pa.; Wessel Duval Co., New York; York Chemical Co., York, Pa.

The New York Market

NEW YORK, May 1, 1922.

In general the chemical market during April was not up to expectations of many observers. Although the early advances were practically all maintained throughout the month, activity was confined to comparatively few commodities, and the remainder of the list was almost entirely neglected. However, leading producers now report a very favorable outlook and in many cases production has been increased considerably in order to take care of recent new business.

DEVELOPMENTS OF THE WEEK

The market during the past week has remained quite steady throughout the entire list. Although buying cannot be called brisk, the general feeling in the trade is very optimistic. The basic reason for this condition lies in the present strong position of caustic soda, which is the recognized barometer of trading in the chemical market. The export demand for this commodity has been very active during the past month and with domestic producers quoting lower prices than foreign competitors the outlook is promising for a continuance of active trading. May shipments are practically sold up among the more important factors and in some instances the output is booked as far ahead as the latter part of June.

One of the leading features in the week's trading was the notable rise in the prices of prussiates. Consumers resumed their former buying operations and a marked difference was noted in the final quotations. Still another feature was the continued activity in the market for barium products. During the week barium chloride touched a new high level. Glaubers salt and chlorate of soda have also attracted increased attention from the consuming industries. Bleaching powder developed a steadier tone. Copper sulphate merited added interest and producers reported a sold-up condition.

GENERAL CHEMICALS

Barium Chloride—Spot material is very scarce and it is doubtful if better than $105 per ton could be done on available round lots. Some dealers quoted up to $110 per ton. The acute shortage is the principal reason for the present strength.

Carbonate of Potash—Spot quotations have shown a firmer tendency and the demand was rather active. Calcined 80-85 per cent was quoted at 5c. per lb. Some odd lots were still available at 4¾c. per lb.

Copper Sulphate—The market for this product is much firmer and the demand seems to be exceeding the supply.

Producers quote prime large crystals 99 per cent at 5½c. per lb. and small crystals at $5.40 per 100 lb. The general tone is good and the consensus is for higher prices in the very near future.

Glaubers Salt — The demand has shown a considerable increase during the past week and large tonnages were moved at higher prices. Several carlots in barrels were sold at $1.05 per 100 lb., with lesser quantities quoted up to $1.25. Bag material did not find a ready market, and quotations continued to sag at 85c. per 100 lb. Domestic prices for bags were held at $1.25 per 100 lb. and $1.40 for barrels.

Prussiate of Soda—The market for this material recorded a sharp advance owing to the renewed interest shown by large consumers. Several odd lots were available at the close of trading at 17½c. per lb., with the majority of holders not inclined to offer at any figure. Shipments were quoted at 17c. per lb.

Soda Ash—The market continued steady throughout the entire week with spot goods quoted firm at $1.80 per 100 lb. for carloads in single bags and up to 2c. per lb. for smaller lots. Barrels were quoted at 2@2½c. per lb. Leading factors offered contracts at $1.20 per 100 lb. in single bags and $1.40 in barrels, basis 48 per cent, f.o.b. works.

Vegetable Oils

Linseed Oil — The market for this material was very steady early last week, but eased up considerably at the close. Crushers were offering shipment oil at 86c. per gal. Consuming interest has fallen off considerably during the last few days, owing to the present high price. English material ex-dock sold as low as 81c. per gal., duty paid. Shipment oil was somewhat higher at 82c. Dutch oil on spot sold at 81½c.

Chinawood Oil — The market on spot was rather steady under an improved inquiry. Spot oil sold in small lots at 13½c. per lb. May arrival at New York was offered at 12½c., with June-July at 12½c. per lb.

Coconut Oil — This material showed a tendency to ease off and some dealers were inclined to shade prices. Prompt shipment from the coast in tanks sold at 7½c. per lb. Ceylon type oil in New York was quoted at 7¾c. per lb., sellers' tanks.

Corn Oil — Offerings of crude corn oil were somewhat scarce and prices ranged from 9¾@10c. per lb. Spot crude in less than carloads sold at 11½c. per lb.

The St. Louis Market

St. Louis, April 25, 1922.

The movement of heavy industrial chemicals since our last report could not be termed vigorous in every respect, but the demand has increased and is showing up very favorably in the larger volume of sales. The lack of confidence prevailing several weeks ago has been entirely subdued by a feeling of optimism which is a positive indication that the improvement will be a permanent one. The demand for chemicals emanating from industrial sources has added greatly to the present condition of the market. Furthermore, with the approach of the spring and summer seasons there are many commodities that will move in a larger way and will add substantially to the volume of business transacted. This should be an opportune time to cover for several months' requirements, as prices in general have begun to advance and probably will continue in this direction with the increased activities.

Alkalis

The singular innovation of a chemical dealer advertising his wares in the daily paper was introduced to the St. Louis market last week, and through it we have the following prices on alkalis: *Caustic soda*, 76 per cent, solid, in 5-drum lots, $3.93 per 100 lb.; flake, 76 per cent, $4.41½ per 100 lb.; *soda ash*, 58 per cent, light, in bags, $2.21½ per 100 lb., in barrels, $2.45 per 100 lb. So far as we are able to determine this price is being met by all dealers. *Bicarbonate* can be obtained at $2.25 per 100 lb. in 5-bbl. lots, with the demand light. *Sal soda* has declined 10c. per 100 lb. during the interval since our last report.

General and Special Chemicals

Reports coming from the heavy *mineral acid* manufacturers are very favorable and the tone of the market has greatly improved during the current month. Manufacturers have today advanced their price on *acid carbolic crystals*, also the liquid medicinal grade, 1c. per lb., with the demand very favorable. *Citric acid* is in good demand, with a scarcity of stock, and an advance in price would not prove at all surprising. *Ammonia water*, 26 deg., has been in better demand for the past several weeks with a firm market. *Carbon bisulphide* is firm and the demand very encouraging. Last week factors in *chloroform* reduced their prices 5c. per lb. on both the U.S.P. and anesthesia grades. Stocks of *copperas* continue to move into consumptive channels as fast as accumulated and the demand is still far in excess of the production. A reduction of 1c. per lb. in the price of c.p. *glycerine* did not stimulate the market extensively, and it is still a slowly moving item; a further decline would not come as a surprise. *Sulphur* is still holding with no change in price and apparently a good demand.

Vegetable Oils and Naval Stores

Castor oil is holding firm, with an increasing demand for spot goods. *Turpentine* can be bought today at 85c. in drums, which happens to be the same as in our last report; the prices have been up and down during the interval.

Paint Materials

Ochers have advanced slightly, while *oxides* suffered a decline. *Zinc oxide*, lead free, is offered at 7¾c. in barrels, 7½c. in bags in carloads; warehouse price at 8c. and 8½c. *Zinc oxide* containing 5 per cent lead at ½c. less, and 8 to 10 per cent lead at ½c. less on above lists. *Barytes* is quoted at $23 in carloads and $24.50 in less than carlots in barrels. Prices per ton for *whiting* follow:

	Barrels	Paper Bags	Cotton Bags
Whiting—Commercial	$15.50	$13.50	$15.00
Extra gilders	16.50	14.50	16.00
Putty whiting	10.50	10.00	11.00
Vera blanc	17.00	15.00	16.50

The Iron and Steel Market

Pittsburgh, April 28, 1922.

The volume of business in finished steel products, as a whole, has been decreasing somewhat and is now at a materially lower level than the average of March. The decrease in general buying is still greater, for there has been some activity in railroad material, particularly in connection with freight cars.

Buyers and sellers alike contribute to the decreased market activity. There is less inquiry on the part of many buyers, including both jobbers and manufacturing consumers, obviously because they anticipated present requirements by buying in February and March, having in mind the coal strike of April 1. Among steel producers there is decidedly less disposition to sell. In most quarters this disinclination is attributed entirely to the coal strike, with its tendency to prevent increases in steel production, but as a matter of fact part of the disinclination is only indirectly connected with the coal strike, the point being that in some cases the steel mill believes that the inquiry is due to the coal strike and thus has a little speculative flavor. There are cases in which a consumer refused to buy recently but now urges a mill to accept his order, when there is no evidence that his actual requirements have changed, the change being in his mental attitude, and the sales manager reflects that such a buyer may change his mind once more.

Strike Situation Largely Met

The steel producers affected by the Connellsville region strikes have largely met the situation. Except in the case of a few merchant furnaces, production is being maintained at nearly if not quite the rate obtaining at the end of March, and in all cases at much above the rates of earlier in the year. Since April 1, when it developed that non-

union strikes in the Connellsville and Lower Connellsville region would be much more extensive than had been expected, there has been aggressive buying of coal by several large interests and in various districts. There is some Connellsville coal available for purchase, production being perhaps maintained by paying "bonuses" to the miners, while there is much coal to be obtained in West Virginia and Kentucky. The Elkhorn, Ky., coal runs under 4 per cent ash and under 0.60 per cent sulphur, lower limits than the Connellsville region ever showed, and there is to be quite a movement of it to the Clairton byproduct plant of the Carnegie Steel Co., which normally has used only Connellsville coal and was moderately well stocked with it on April 1. The Carnegie company is blowing thirty-one or thirty-two blast furnaces, against thirty-four on April 1, but might be operating forty by this time had no strikes occurred. The Steel Corporation has increased its steel production in the Chicago district, which would scarcely be affected by the coal strike before July.

Steel ingot production cannot be estimated closely but is probably running at between 36,000,000 and 38,000,000 tons a year. The rate was about 35,000,000 tons April 1, 30,000,000 tons March 1 and 20,000,000 tons in December. Thus if a material decrease in steel production should be forced, the rate would not be set far back in point of time.

As a matter of fact, the coal strike is probably doing the steel-producing industry more good than harm. Buyers are very anxious to receive deliveries of all material already bought and there is more anxiety to buy on the part of some consumers hitherto doubtful. Prices asked are being paid without demur, and concessions from regular market prices have practically disappeared.

There are rumors, as would naturally be expected, of premiums being paid for prompt deliveries, but there is no reason to suppose that premium prices are being paid on any tonnage worth considering. Rolling schedules are now so well filled that consumers and distributors need more stock than formerly, but this does not mean that their deliveries will not be heavy, in general, or equal to actual requirements.

Prices

Market prices are quotable as follows: Bars, shapes and plates, 1.50c.; hoops, bands and hot rolled strips, 2c.; blue annealed sheets, 2.40c.; black sheets, 3.15c.; galvanized sheets, 4.15c.; automobile sheets, 4.50c.; standard steel pipe, 71 per cent basing discount. Independent wire mills are rigidly adhering to $2.50 on nails, while the American Steel & Wire Co. continues its old price of $2.40.

It has become very difficult to buy any semi-finished steel, as the mills prefer to reserve their capacity for their own regular finished steel products. There is no demand for billets, but there is quite a demand for sheet bars, partly because some sheet mills neglected to cover fully on sheet bars when they were selling sheets so freely prior to their recent advance of $3 a ton. Sheet bars were then $29. Now it is certain they cannot be bought at less than $33, and there is a question what price really would bring out tonnage.

Pig Iron and Coke

The pig-iron market in this general territory has almost disappeared. Few merchant furnaces were running when the coal strike started and some of these have had to bank, the result being that there are no regular sellers in the market. Basic pig iron has sold at $24 furnace, against $18 at the beginning of the month. Bessemer and foundry may be quoted nominally at the same figure. There is little inquiry, in point of volume, but there may be two or three insistent buyers of basic iron.

The Connellsville coke market is very narrow in point of tonnage. The merchant furnaces, in view of their low-priced sales of iron, would not buy at over $3.50. Offerings are very limited, and in one or two cases steel interests have been buying, making a market at the moment of $6, against not over $3.50 at the end of March and $2.75@$3 in January. Foundry coke is $6.50, with offerings and inquiry light.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	... – ...	$0.38 – $0.40
Acetone	lb.	$0.08 – $0.09	.09½ – .10
Acid, acetic, 28 per cent	100 lbs.	2.35 – 2.50	2.55 – 3.00
Acetic, 56 per cent	100 lbs.	5.00 – 5.25	5.30 – 5.50
Acetic, glacial, 99½ per cent, carboys, 100 lbs.		9.00 – 9.50	9.75 – 10.00
Boric, crystals	lb.	.11 – .11½	.11½ – .12
Boric, powder	lb.	.11 – .11½	.11½ – .12½
Citric	lb.	... – ...	.45½ – .46
Hydrochloric	100 lb.	1.10 – 1.20	1.25 – 1.70
Hydrofluoric, 52 per cent	lb.	.11 – .11½	.11½ – .12
Lactic, 44 per cent tech	lb.	.09½ – .10	.10½ – .12
Lactic, 22 per cent tech	lb.	.04 – .04½	.04½ – .05
Molybdic, c.p.	lb.	3.00 – 3.25	3.30 – 3.75
Muriatic, 20 deg. (see hydrochloric)		... – ...	... – ...
Nitric, 40 deg	lb.	.06 – .06½	.06½ – .07
Nitric, 42 deg	lb.	.06½ – .06¾	.07 – .07½
Oxalic, crystals	lb.	.11½ – .12	.12½ – .13
Phosphoric, 50 per cent solution	lb.	.08 – .08½	.08½ – .09½
Picric	lb.	.22 – .24	.24½ – .30
Pyrogallic, resublimed	lb.	... – ...	1.65 – 1.75
Sulphuric, 60 deg., tank cars	ton	11.00 – 12.00	... – ...
Sulphuric, 60 deg., drums	ton	12.00 – 14.00	... – ...
Sulphuric, 66 deg., tank cars	ton	17.00 – 17.50	... – ...
Sulphuric, 66 deg., drums	ton	20.00 – 20.50	21.00 – 22.00
Sulphuric, 66 deg., carboys	ton	... – ...	... – ...
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	19.50 – 20.00	... – ...
Sulphuric, fuming, 20 per cent (oleum) drums	ton	22.00 – 22.50	23.00 – 24.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	31.00 – 32.00	33.00 – 34.00
Tannic, U. S. P.	lb.	... – ...	.60 – .75
Tannic (tech.)	lb.	.40 – .45	.46 – .50
Tartaric, imported crystals	lb.	... – ...	.26½ – .28
Tartaric acid, imported, powdered	lb.	... – ...	.27½ – .30
Tartaric acid, domestic	lb.	... – ...	... – .30
Tungstic, per lb. of WO	lb.	... – ...	1.00 – 1.10
Alcohol, ethyl	gal.	... – ...	4.75 – 4.95
Alcohol, methyl (see methanol)		... – ...	... – ...
Alcohol, denatured, 188 proof No. 1	gal.	... – ...	.32 – .34
Alcohol, denatured, 188 proof No. 5	gal.	... – ...	.32 – .34
Alum, ammonia, lump	lb.	.03½ – .03¾	.04 – .04½
Alum, potash, lump	lb.	.03¾ – .04	.04½ – .05
Alum, chrome lump	lb.	.07½ – .08	.08½ – .08¾
Aluminum sulphate, commercial	100 lb.	1.50 – 1.65	1.70 – 2.25
Aluminum sulphate, iron free	lb.	.02½ – .02¾	.03 – .03½
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07½ – .07¾	.08 – .08½
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30 – .30½	.31 – .33
Ammonium carbonate, powder	lb.	.07 – .07½	.08 – .09
Ammonium nitrate	lb.	.06 – .06½	.06½ – .07½
Amylacetate tech.	gal.	... – ...	2.00 – 2.25
Arsenic, white, powdered	lb.	.06½ – .07	.07½ – .07¾
Arsenic, red, powdered	lb.	.12 – .12½	.12½ – .13
Barium chloride	ton	108.00 – 110.00	111.00 – 115.00
Barium dioxide (peroxide)	lb.	.20 – .21	.21½ – .22
Barium nitrate	lb.	.06½ – .07	.07½ – .08¼
Barium sulphate (precip.) (blanc fixe)	lb.	.03½ – .04	.04½ – .04¾
Blanc fixe, dry	lb.	.04 – .04½	... – ...
Blanc fixe, pulp	ton	45.00 – 55.00	... – ...
Bleaching powder	100 lb.	1.60 – 1.75	1.80 – 2.75
Blue vitriol (see copper sulphate)		... – ...	... – ...
Borax	lb.	.05½ – .05¾	.06 – .06½
Brimstone (see sulphur, roll)		... – ...	... – ...
Bromine	lb.	.27 – .28	.28½ – .35
Calcium acetate	100 lbs.	1.75 – 2.00	... – ...
Calcium carbide	lb.	.04½ – .04¾	.05 – .05½
Calcium chloride, fused, lump	ton	24.00 – 24.50	24.75 – 27.00
Calcium chloride, granulated	lb.	.01½ – .01¾	.02 – .02½
Calcium peroxide	lb.	... – ...	1.40 – 1.50
Calcium phosphate, tribasic	lb.	... – ...	.15 – .16
Camphor	lb.	... – ...	.80 – .82
Carbon bisulphide	lb.	.06 – .06¼	.06½ – .07¼
Carbon tetrachloride, drums	lb.	.09½ – .10	.10½ – .12
Carbonyl chloride, (phosgene)	lb.	... – ...	.60 – .75
Caustic potash (see potassium hydroxide)		... – ...	... – ...
Caustic soda (see sodium hydroxide)		... – ...	... – ...
Chalk, precip.—domestic, light	lb.	.04½ – .04¾	... – ...
Chalk, precip.—domestic, heavy	lb.	.03½ – .03¾	... – ...
Chalk, precip.—imported, light	lb.	.04½ – .05	... – ...
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.05 – .05½	.05½ – .06
Chloroform	lb.	... – ...	.37 – .40
Cobalt oxide	lb.	... – ...	2.00 – 2.10
Copperas	ton	15.00 – 16.00	16.50 – 30.00
Copper carbonate, green precipitate	lb.	.19 – .20	.20½ – .21
Copper cyanide	lb.	... – ...	.58 – .60
Copper sulphate, crystals	100 lb.	5.50 – 5.60	5.65 – 6.15
Cream of tartar	lb.	... – ...	.24 – .26
Epsom salt (see magnesium sulphate)		... – ...	... – ...
Ethyl acetate com. 85%	gal.	... – ...	.60 – .65
Ethyl acetate, pure (acetic ether, 98% to 100%)	gal.	... – ...	.90 – .95
Formaldehyde, 40 per cent	lb.	.08½ – .09	.09½ – .10
Fullers earth, f.o.b. mines	net ton	16.00 – 17.00	... – ...
Fullers earth-imported powdered-net	ton	30.00 – 32.00	... – ...
Fusel oil, ref.	gal.	... – ...	2.15 – 2.50
Fusel oil, crude	gal.	... – ...	1.30 – 1.50
Glauber's salt (see sodium sulphate)		... – ...	... – ...
Glycerine, c. p. drums extra	lb.	... – ...	.15 – .15½
Iodine, resublimed	lb.	... – ...	4.05 – 4.15
Iron oxide, red	lb.	... – ...	.12 – .18
Lead acetate	lb.	... – ...	.09½ – .12
Lead arsenate, powd	lb.	.14 – .14½	.14½ – .15½
Lead nitrate	lb.	... – ...	.15 – .20
Litharge	lb.	.07½ – .07¾	.08 – .08½
Magnesium carbonate, technical	lb.	.06 – .06½	.06½ – .08
Magnesium sulphate, U. S. P.	100 lb.	2.50 – 2.60	2.65 – 2.85
Magnesium sulphate, technical	100 lb.	... – ...	1.00 – 1.80
Methanol, 95%	gal.	... – ...	.57 – .58
Methanol, 97%	gal.	... – ...	.59 – .60
Nickel salt, double	lb.	... – ...	.11 – .11½
Nickel salt, single	lb.	... – ...	.11 – .11½
Phosgene (see carbonyl chloride)		... – ...	... – ...
Phosphorus, red	lb.	.45 – .46	.47 – .50
Phosphorus, yellow	lb.	... – ...	.30 – .35

		Carlots	Less Carlots
Potassium bichromate	lb.	.10½ – .10½	.10½ – 13
Potassium bromide, granular	lb.	..... –	.17 – .20
Potassium carbonate, U. S. P.	lb.	.12 – .12½	.13 – .16
Potassium carbonate, 80–85%	lb.	.05 – .05½	.05½ – .06
Potassium chlorate, crystals	lb.	.06½ – .06½	.06½ – .08
Potassium cyanide	lb.	..... –	.42 – .45
Potassium hydroxide (caustic potash)	100 lb.	6.00 – 6.10	6.25 – 7.00
Potassium iodide	lb.	..... –	3.10 – 3.15
Potassium nitrate	lb.	.07½ – .07½	.08 – .09
Potassium permanganate	lb.	.15 – .15½	.16 – .22
Potassium prussiate, red	lb.	nominal	nominal
Potassium prussiate, yellow	lb.	.28½ – .29	.29½ – .29½
Rochelle salts (see sodium potas. tartrate)		..... –	..... – .....
Salammoniac, white, granular	lb.	.07 – .07½	.07½ – .08
Salammoniac, gray, granular	lb.	.07½ – .07½	.08 – .08½
Salsoda	100 lb.	1.40 – 1.45	1.50 – 1.80
Salt cake (bulk)	ton	18.00 – 20.00	..... – .....
Soda ash, light	100 lb.	1.80 – 2.00	2.05 – 2.60
Soda ash, dense	100 lb.	1.85 – 1.95	2.00 – 2.50
Sodium acetate	lb.	.04½ – .04½	.04½ – .05
Sodium bicarbonate	100 lb.	1.80 – 1.90	1.95 – 2.40
Sodium bichromate	lb.	.07½ – .07½	.08 – .08½
Sodium bisulphate (nitre cake)	ton	4.50 – 4.60	4.65 – 5.50
Sodium bisulphite powdered, U.S.P.	lb.	.04½ – .04½	.04½ – .05½
Sodium chlorate	lb.	.06½ – .07	.07½ – .07½
Sodium chloride	long ton	12.00 – 13.00	..... – .....
Sodium cyanide	lb.	.22 – .23	.23½ – .25
Sodium fluoride	lb.	.09½ – .10	.10½ – .10½
Sodium hydroxide (caustic soda)	100 lb.	3.70 – 3.75	3.80 – 4.25
Sodium hyposulphite	lb.	.03 – .03½	.03½ – .03½
Sodium nitrite	lb.	.08½ – .09	.09½ – .09½
Sodium peroxide, powdered	lb.	.28 – .30	.31 – .35
Sodium phosphate, dibasic	lb.	.03½ – .04	.04½ – .04½
Sodium potassium tartrate (Rochelle salts)	lb.	..... –	.18 – .21
Sodium prussiate, yellow	lb.	.17½ – .17½	.18 – .18½
Sodium silicate, solution (40 deg.)	100 lb.	1.00 – 1.15	1.20 – 1.50
Sodium silicate, solution (60 deg.)	100 lb.	2.35 – 2.50	2.55 – 2.90
Sodium sulphate, crystals (glaubers salt)	100 lbs.	1.00 – 1.15	1.20 – 1.50
Sodium sulphide, fused, 60-62 per cent (cone.)	lb.	.04½ – .04½	.04 – .05½
Sodium sulphite, crystals	lb.	.03 – .03½	.03½ – .04½
Strontium nitrate, powdered	lb.	.09½ – .10	.10½ – .12
Sulphur chloride, yellow	lb.	.04½ – .05	.05½ – .06
Sulphur, crude	ton	18.00 – 20.00	..... – .....
Sulphur dioxide, liquid, cylinders extra	lb.	.08 – .08½	.09 – .10
Sulphur (sublimed), flour	100 lb.	..... –	2.25 – 3.10
Sulphur, roll (brimstone)	100 lb.	..... –	2.00 – 2.75
Tale—imported	ton	30.00 – 40.00	..... – .....
Tale—domestic powdered	ton	18.00 – 25.00	..... – .....
Tin bichloride	lb.	.09 – .09½	.09½ – .10
Tin oxide	lb.	..... –	.37 – .38
Zinc carbonate	lb.	.14 – .14½	.14½ – .15½
Zinc chloride, gran.	lb.	.05½ – .06	.06½ – .06½
Zinc cyanide	lb.	.42 – .44	.45 – .47
Zinc oxide, XX	lb.	.07½ – .08	.08½ – .08½
Zinc sulphate	100 lb.	2.75 – 3.00	3.05 – 3.30

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.00 — $1.05
Alpha-naphthol, refined	lb.	1.10 — 1.15
Alpha-naphthylamine	lb.	.30 — .31
Aniline oil, drums extra	lb.	.16 — .16
Aniline salts	lb.	.22 — .24
Anthracene, 80% in drums (100 lb.)	lb.	.75 — 1.00
Benzaldehyde U.S.P.	lb.	1.25 — 1.30
Benzidine, base	lb.	.85 — .95
Benzidine sulphate	lb	.75 — .85
Benzoic acid, U.S.P.	lb.	.65 — .70
Benzoate of soda, U.S.P.	lb.	.55 — .57
Benzene, pure, water-white, in drums (100 gal.)	gal.	.29 — .35
Benzene, 90%, in drums (100 gal.)	gal.	.27 — .32
Benzyl chloride, 95-97%, refined	lb.	.25 — .27
Benzyl chloride, tech.	lb.	.20 — .23
Beta-naphthol benzoate	lb.	3.75 — 4.00
Beta-naphthol, sublimed	lb.	.55 — .60
Beta-naphthol, tech	lb.	.26 — .28
Beta-naphthyla mine, sublimed	lb.	1.50 — 1.60
Cresol, U. S. P., in drums (100 lb.)	lb.	.12 — .15
Ortho-cresol, in drums (100 lb.)	lb.	.16 — .18
Cresylic acid, 97–99%, straw color, in drums	gal.	.53 — .55
Cresylic acid, 95-97%, dark, in drums	gal.	.48 — .50
Dichlorbenzene	lb.	.06 — .09
Diethylaniline	lb.	.70 — .75
Dimethylaniline	lb.	.38 — .40
Dinitrobenzene	lb.	.22 — .25
Dinitroclorbenzene	lb.	.22 — .24
Dinitronaphthalene	lb.	.30 — .32
Dinitrophenol	lb.	.33 — .35
Dinitrotoluene	lb.	.22 — .24
Dip oil, 25%, car lots, in drums	gal.	.24 — .26
Diphenylamine	lb.	.59 — .65
H-acid	lb.	.85 — 1.00
Meta-phenylenediamine	lb.	.90 — 1.00
Monochlorbenzene	lb.	.14 — .15
Monoethylaniline	lb.	1.05 — 1.25
Naphthalene crushed, in bbls.	lb.	.06 — .06½
Naphthalene, flake	lb.	.06½ — .07
Naphthalene, balls	lb.	.08 — .08½
Naphthionic acid, crude	lb.	.65 — .70
Nitrobensene	lb.	.10 — .12
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	.15 — .17½
Ortho-amidophenol	lb.	2.50 — 2.60
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.70 — .75
Ortho-nitro-toluene	lb.	.12 — .15
Ortho-toluidine	lb.	.16 — .20
Para-amidophenol, base	lb.	1.25 — 1.30
Para-amidophenol, HCl	lb.	1.30 — 1.35
Para-dichlorbenzene	lb.	.14 — .16
Paranitroaniline	lb.	.75 — .77
Para-nitrotoluene	lb.	.60 — .70
Para-phenylenediamine	lb.	1.50 — 1.55
Para-toluidine	lb.	1.05 — 1.15
Phthalic anhydride	lb.	.36 — .38
Phenol, U. S. P., drums	lb.	.13 — .15
Pyridine	gal.	1.75 — 2.75
Resorcinol, technical	lb.	1.30 — 1.35
Resorcinol, pure	lb.	1.75 — 1.80
Salicylic acid, tech., in bbls.	lb.	.24 — .24½
Salicylic acid, U. S. P.	lb.	.25 — .26
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.25 — .28
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.10 — .12
Sulphanilic acid, crude	lb.	.24 — .26
Tolidine	lb.	1.20 — 1.30
Toluidine, mixed	lb.	.30 — .35
Toluene, in tank cars	gal.	.25 — .28
Toluene, in drums	gal.	.30 — .35
Xylidines, drums, 100 gal.	lb.	.40 — .45
Xylene, pure, in drums	gal.	.40 — .45
Xylene, pure, in tank cars	gal.	.45 — .....
Xylene, commercial, in drums, 100 gal.	gal.	.33 — .35
Xylene, commercial, in tank cars	gal.	.30 — .....

Waxes

Prices based on original packages in large quantities.

Bayberry Wax	lb.	$0.20 — $0.21
Beeswax, refined, dark	lb.	.26 — .28
Beeswax, refined, light	lb.	.30 — .32
Beeswax, white pure	lb.	.35 — .40
Candellila, wax	lb.	.25 — .26
Carnauba, No. 1	lb.	.45 — .46
Carnauba No. 2, North Country	lb.	.25 — .25½
Carnauba, No. 3, North Country	lb.	.16 — .16½
Japan	lb.	.17 — .18
Montan, crude	lb.	.04 — .04½
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.04½ — .04½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.02½ — .....
Paraffine waxes, refined, 118-120 m.p.	lb.	.03 — .03½
Paraffine waxes, refined, 125 m.p.	lb.	.03½ — .03½
Paraffine waxes, refined, 128-130 m.p.	lb.	.04 — .04½
Paraffine waxes, refined, 133-135 m.p.	lb.	.04½ — .04½
Paraffine waxes, refined, 135-137 m.p.	lb.	.05 — .05½
Stearic acid, single pressed	lb.	.09 — .09½
Stearic acid, double pressed	lb.	.09½ — .09½
Stearic acid, triple pressed	lb.	.10½ — .11

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl.	280 lb.	$5.25 — 5.30
Rosin E-I	280 lb.	5.35 — 5.40
Rosin K-N	280 lb.	5.45 — 6.55
Rosin W. G.-W. W.	280 lb.	7.00 — 7.25
Wood rosin, bbl.	280 lb.	6.25 — .....
Spirits of turpentine	gal.	.92 — 93½
Wood turpentine, steam dist.	gal.	.85 — .....
Wood turpentine, dest. dist.	gal.	.70 — .70
Pine tar pitch, bbl.	200 lb.	..... — 6.00
Tar, kiln burned, bbl. (500 lb.)	bbl.	..... — 10.00
Retort tar, bbl.	500 lb.	— 9.00
Rosin oil, first run	gal.	.37 — .....
Rosin oil, second run	gal.	.39 — .....
Rosin oil, third run	gal.	.46 — .....
Pine oil, steam dist., sp.gr., 0.930-0.940	gal.	$1.90
Pine oil, pure, dest. dist.	gal.	1.50
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.	.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.35
Pine tar, double ref., sp.gr. 0.965-0.990	gal.	.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.	.35
Turpentine, crude, sp. gr., 0.900-0.970	gal.	1.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.	.35
Pinewood creosote, ref.	gal.	.52

Fertilizers

Ammonium sulphate, f.a.s., N.Y.	100 lb.	3.75 — .....
Blood, dried, f.o.b., N. Y.	unit	3.65 — .....
Bone, 3 and 50, ground, raw	ton	27.00 — 28.00
Fish scrap, dom., dried, f.o.b. works	unit	3.10 — 3.20
Nitrate soda	100 lb.	2.90 — 3.00
Tankage, high grade, f.o.b. Chicago	unit	3.00 — 3.10
Phosphate rock, f.o.b. mines, Florida pebble, 68-72%	ton	5.50 — 7.00
Tennessee, 78-80%	ton	8.50 — 9.00
Potassium muriate, 80%	ton	33.50 — 35.00
Potassium sulphate	unit	1.00 — .....

Crude Rubber

Para—Upriver fine	lb.	$0.18½ — .19
Upriver coarse	lb.	.13½ — .13½
Upriver caucho ball	lb.	.14 — .14½
Plantation—First latex crepe	lb.	.16½ — .16½
Ribbed smoked sheets	lb.	.16½ — .....
Brown crepe, thin, clean	lb.	.14½ — .....
Amber crepe No. 1	lb.	.16 — .....

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.10 — $0.10½
Castor oil, AA, in bbls.	lb.	.11½ — .12
China wood oil, in bbls.	lb.	.13½ — .13½
Coconut oil, Ceylon grade, in bbls.	lb.	.08½ — .09
Coconut oil, Cochin grade, in bbls.	lb.	.09½ — .09½
Corn oil, crude, in bbls.	lb.	.11½ — .11½
Cottonseed oil, crude (f. o. b. mill)	lb.	.09½ — .10
Cottonseed oil, summer yellow	lb.	.12 — .12½
Cottonseed oil, winter yellow	lb.	.13½ — .13
Linseed oil, raw, car lots (domestic)	gal.	.86 — .87
Linseed oil, raw, tank cars (domestic)	gal.	.82 — .83
Linseed oil, in 5-bbl lots (domestic)	gal.	.89 — .90

Olive oil, denatured	gal.	1.12 —	1.15½
Palm, Lagos	lb.	.07½ —	.07¼
Palm, Niger	lb.	.05½ —	.06
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.09½ —	.10
Peanut oil, refined, in bbls	lb.	.12½ —	.13
Rapeseed oil, refined in bbls	gal.	.83 —	.84
Rapeseed oil, blown, in bbls	gal.	.86 —	.87
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.11½ —	....
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.09¼ —	....
FISH			
Light pressed menhaden	gal.	$0.54 —	....
Yellow bleached menhaden	gal.	.57 —	....
White bleached menhaden	gal.	.56 —	....
Blown menhaden	gal.	.61 —	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Asbestos, crude No. 1, f.o.b., Quebec, Canada	short ton	$900.00	$1,100.00
Asbestos, shingle stock, f.o.b., Quebec, Canada	short ton	70.00 —	110.00
Asbestos, cement stock, f.o.b., Quebec, Canada	short ton	15.00 —	17.50
Barytes, ground, white, f.o.b. mills	net ton	17.00 —	23.00
Barytes, ground, off color f.o.b. mills	net ton	13.00 —	21.00
Barytes, floated, f.o.b. St. Louis	net ton	23.00 —	24.00
Barytes, crude f.o.b. mines	net ton	8.00 —	8.00
Casein	lb.	.10½ —	.12
China clay (kaolin) crude, f.o.b. mines, Georgia	net ton	6.00 —	8.00
China clay (kaolin) washed, f.o.b. Georgia	net ton	8.00 —	9.00
China clay (kaolin) powdered, f.o.b. Georgia	net ton	12.00 —	20.00
China clay (kaolin) crude f.o.b. Virginia points	net ton	8.00 —	12.00
China clay (kaoli n)ground, f.o.b. Virginia points	net ton	13.00 —	20.00
China clay (kaolin), imported, lump	net ton	14.00 —	20.00
China clay (kaolin), imported, powdered	net ton	30.00 —	35.00
Feldspar, No. 1 pottery grade	long ton	6.50 —	6.75
Feldspar, No. 2 pottery grade	long ton	5.75 —	5.90
Feldspar, No. 1 soap grade	long ton	7.00 —	7.50
Feldspar, No. 1 Canadian, for mill	long ton	22.00 —	22.50
Graphite, Ceylon lump, first quality	lb.	.05 —	.07
Graphite, Ceylon chip	lb.	.04 —	.05½
Graphite, high grade amorphous crude	ton	18.00 —	45.00
Kieselguhr, f.o.b. mines, Cal	per ton	40.00 —	....
Kieselguhr, f.o.b. N. Y	per ton	55.00 —	60.00
Magnesite, calcined (crude)	per ton	12.00 —	15.00
Pumice stone, imported	lb.	.03 —	.05
Pumice stone, domestic, lump	lb.	.05 —	.05½
Pumice stone, domestic, ground	lb.	.06 —	.07
Shellac, orange fine	lb.	.86 —	.87
Shellac, orange superfine	lb.	.88 —	.89
Shellac, A. C. garnet	lb.	.68 —	.69
Shellac, T. N.	lb.	.83 —	.84
Silica, glass sand, f.o.b. Indiana	per ton	1.25 —	1.50
Silica, sand blast material, f.o.b. Indiana	per ton	2.25 —	4.50
Silica, amorphous, 250 mesh, f.o.b. Illinois	per ton	16.00 —	16.00
Silica, building sand, f.o.b. Pa	per ton	2.00 —	2.75
Soapstone	ton	12.00 —	15.00
Talc, 200 mesh, f.o.b. Vermont	ton	7.00 —	12.00
Talc, 200 mesh, f.o.b. Georgia	ton	7.50 —	12.00
Talc, 200 mesh, f.o.b. Los Angeles	ton	16.00 —	20.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh	per 1,000	$130.00	
Carborundum refractory brick, 9-in.	1,000	1100.00	
Chrome brick, f.o.b. Eastern shipping points	net ton	41–44	
Chrome cement, 40-50% Cr_2O_3	net ton	30–32	
Chrome cement, 40-45% Cr_2O_3, sacks, in car lots, f.o.b. Eastern shipping points	net ton	30–32	
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	32–37	
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	27–30	
Magnesite brick, 9-in. straight (f.o.b. works)	net ton	55	
Magnesite brick, 9-in. arches, wedges and keys	net ton	70	
Magnesite brick, soaps and splits	net ton	90	
Silica brick, 9-in. sizes, f.o.b. Chicago district	1,000	35–37	
Silica brick, 9-in. sizes, f.o.b. Birmingham district	1,000	37–39	
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa	1,000	27–30	

Ferro-Alloys

All f.o.b. Works

Ferrocarbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00 —	$225.00
Ferrochromium, per lb. of Cr contained, 6–8% carbon, carlots	lb.	.11 —	....
Ferrochromium, per lb. of Cr contained, 4-6% carbon, carlots	lb.	.11½ —	....
Ferromanganese, 76-80% Mn, domestic	gross ton	67.00 —	69.00
Spiegeleisen, 18-22% Mn	gross ton	30.00 —	35.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo	lb.	2.00 —	2.25
Ferrosilicon, 10-15%	gross ton	38.00 —	40.00
Ferrosilicon, 50%	gross ton	56.00 —	58.00
Ferrosilicon, 75%	gross ton	115.00 —	120.00
Ferrotungsten, 70-80%, per lb. of contained W	lb.	.45 —	.50
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	6.00 —	....
Ferrovanadium, 30-40% per lb. of contained V	lb.	3.00 —	3.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content	net ton	$6.00 —	$12.00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	ton	19.00 —	20.00
Chrome ore, 50% Cr_2O_3, f.o.b. Atlantic seaboard	ton	19.00 —	20.00
Coke, foundry, f.o.b. ovens	net ton	4.25 —	4.75
Coke, furnace, f.o.b. ovens	net ton	3.50 —	3.75
Fluorspar, gravel, f.o.b. mines, New Mexico	net ton	12.00 —	....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	20.00 —	22.00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01½ —	.01¾
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	unit	.26½ —	.27
Manganese ore, chemical (MnO_2)	net ton	60.00 —	65.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y.	lb.	.40 —	.42
Monazite, per unit of ThO_2, c.i.f., Atlantic seaport	unit	27.00 —	....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.12 —	.12
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport	unit	.13 —	.13
Pyrites, domestic, fines, f.o.b. mines, Ga	unit	.11 —	.12
Rutile, 95% TiO_2 per lb. ore	lb.	.12 —	....
Tungsten, scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	2.25 —	2.50
Tungsten, wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C	unit	2.50 —	2.75
Uranium ore (carnotite) per lb. of U_3O_8	lb.	1.25 —	1.75
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.25 —	2.50
Vanadium pentoxide, 99%	lb.	12.00 —	14.00
Vanadium ore, per lb. of V_2O_5 contained	lb.	1.00 —	....
Zircon, washed, iron free, f.o.b. Pablo, Florida	lb.	.04½ —	.13½

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	12.875
Aluminum, 98 to 99 per cent	19.00
Antimony, wholesale lots, Chinese and Japanese	5.00
Nickel, ordinary (ingot)	36.00
Nickel, electrolytic	39.00
Nickel, electrolytic, resale	30.00–33.00
Monel metal, shot and blocks	32.00
Monel metal, ingots	35.00
Monel metal, sheet bars	38.00
Tin, 5-ton lots, Straits	31.125
Lead, New York, spot	5.25–5.00
Lead, E. St. Louis, spot	5.25
Zinc, spot, New York	5.55
Zinc, spot, E. St. Louis	5.05

OTHER METALS

Silver (commercial)	oz.	$0.67¼
Cadmium	lb.	1.00–1.10
Bismuth (500 lb. lots)	lb.	2.00@2.10
Cobalt	lb.	3.00@3.25
Magnesium	lb.	1.15
Platinum	oz.	85.00@ 90.00
Iridium	oz.	160.00@170.00
Palladium	oz.	55.00@ 60.00
Mercury	75 lb.	56–57

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	18.75
Copper bottoms	27.75
Copper rods	19.25
High brass wire	16.75
High brass rods	14.25
Low brass wire	18.25
Low brass rods	18.75
Brazed brass tubing	23.00
Brazed bronze tubing	28.00
Seamless copper tubing	20.75
Seamless high brass tubing	18.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current
Copper, heavy and crucible	10.25@10.50
Copper, heavy and wire	10.00@10.25
Copper, light and bottoms	7.75@ 8.25
Lead, heavy	3.90@ 4.15
Lead, tea	2½–2
Brass, heavy	4.50@ 4.75
Brass, light	4.00@ 4.25
No. 1 yellow brass turnings	4.00@ 4.25
Zinc	2.00@ 2.25

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and arger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York*	Chicago
Structural shapes	$2.48	$2.38
Soft steel bars	2.38	2.28
Soft steel bar shapes	2.38	2.28
Soft steel bands	2.98	2.88
Plates, ¼ to 1 in. thick	2.48	2.38

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn.

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

GEIGER—The Sumter Farm & Stock Co. has preliminary plans under way for the establishment of a new mill for the manufacture of cottonseed oil specialties.

ANNISTON—The Farmers' Union Warehouse Co. is considering the erection of a new mill for cottonseed oil manufacture. Work will be commenced in the near future. G. W. Eichelberger is president.

California

OAKLAND—E. H. Hart, secretary of the Oakland Merchants' Exchange, is in negotiation with the La Blume Soap Co., Paris, France, for the erection of a local plant for the manufacture of high-grade soap products. A site is being selected. The project is estimated to cost about $1,000,000, including plant buildings and machinery.

PITTSBURGH—The King Mfg. Co. has completed the erection of a new local mill for the manufacture of plaster board specialties, and will commence production under an initial output of about 5,000 sq.ft. a day. This will be increased at a later date. R. W. King is president and general manager.

SAN FRANCISCO—The Magnolia Metal Co., Pacific Bldg., has awarded a contract to Frederick Moller, 180 Jessie St., for the erection of a new 1-story plant at Bryant and Sterling Sts., to cost about $15,000. Dodge A. Reidy, Pacific Bldg., is architect. Work will be commenced at once.

SAN FRANCISCO—The National Magnesite Products Corp., represented by Sterling Carr, 201 Sansome St., has acquired the property and equipment of the Sonoma Magnesite Co., in the Guerneville Section, Sonoma County, Cal., at public sale, for a consideration of about $175,000. The new owner plans for early operations at the plant and will make a number of improvements.

Florida

BAGDAD—The Bagdad Land & Lumber Co. has arranged for a bond issue of $1,200,000, a portion of the proceeds to be used in connection with the construction of its proposed new turpentine mill on a site recently acquired in Escambia County, Ala. W. B. Harbeson is president.

Illinois

HIGHLAND PARK—The North Shore Sanitary District, Lake Forest, Ill., has preliminary plans under way for the construction of a new purification plant on Gillette Ave., Highland Park, to cost about $125,000, including equipment. Alvord, Burdick & Howson, 8 Dearborn St., Chicago, are engineers.

Indiana

SEYMOUR—The Buhner Fertilizer Co. is considering tentative plans for the rebuilding of the portion of its plant, destroyed by fire, April 12, with loss estimated at about $50,000. Ferdinand Buhner heads the company.

Kentucky

ASHLAND—In addition to a number of improvements in its present plant, the Ashland Firebrick Co., Winchester Ave., will build a 1-story addition, 135 x 190 ft., to be equipped for general manufacture, to total about 50,000 firebrick and other refractory shapes per day. The building contract has been let. E. H. Gartrell is general manager.

LOUISVILLE—The Producers' Wood Preserving Co., an interest of the Ayer & Lord Tie Co., 80 East Jackson Blvd., Chicago, Ill., is completing plans and will soon commence the erection of its proposed new local creosoting plant, to cost about $200,000, including equipment. Oscar E. Bond, Marion E. Taylor Bldg., Louisville, is in charge.

Louisiana

MONROE—The Southwest Pulp & Paper Co. has acquired a tract of property in the vicinity of the Monroe-Columbia Highway, a few miles from the city, totaling about 18 acres of land, as a site for the erection of a new pulp and paper mill. Plans will be placed under way at an early date, and it is expected to begin construction later in the year. The plant is estimated to cost about $250,000, including equipment.

SHREWSBURY—Fire April 21 destroyed the local plant of the Armour Fertilizer Works, 209 West Jackson Blvd., Chicago, Ill., with loss estimated at about $250,000, including buildings, equipment and stock. It is said that the plant will be rebuilt.

CEDAR GROVE—The Louisiana Oil Refining Corp. has leased for an indefinite period the local refinery of the International Oil & Gas Corp., and will place the plant in operation at an early date for the refining of crude oil from the Bellevue field. A number of improvements will be made. The plant was shut down about a year ago, and has a rated capacity of 1,000 bbl. a day.

Maryland

EVERGREEN — The Loyola College Trustees, James A. S. McEneany, 700 North Calvert St., Baltimore, president, will soon take bids for the erection of a 2-story chemistry-biology building at the institution, estimated to cost about $200,000. Otto G. Simonson, Maryland Casualty Bldg., Baltimore, is architect.

SNOWHILL—The plant of the Snowhill Brick Co. has been leased by A. J. Laurenson and William F. Johnson, both of Norfolk, Va., who plan to place the works in operation at an early date. A number of improvements will be made.

BALTIMORE — The Oil Products Co. has leased the 3-story building at 302 North Holliday St. for a new local plant.

Massachusetts

EVERETT—A portion of the plant of the Beacon Oil Works, South Everett, including compressor building, was destroyed by fire April 14, with loss reported at $12,000.

Michigan

DETROIT—The Detroit Soda Products Co., 9077 West Jefferson St., is completing plans and will soon take bids for the erection of a 2-story addition to its plant, 60 x 80 ft. L. B. Alger is president.

Mississippi

JACKSON—The Hi-Power Mfg. Syndicate has leased a local building for the establishment of a plant for the manufacture of battery fluids and other chemical products. Operations will be commenced at an early date.

Missouri

KANSAS CITY—The American Foundry & Mfg. Co., Kansas City Life Bldg., will defer temporarily the erection of its proposed new 1-story foundry, 90 x 140 ft., at 18th and Manchester Aves., estimated to cost about $30,000. Plans have been drawn. H. H. Akers is general manager.

Montana

GREAT FALLS — The American Refining Co. is planning for the erection of an addition to its oil refinery, for general service operations and production.

New Jersey

WOODSTOWN—The South Jersey Farmers' Exchange is selecting a site for the erection of a new fertilizer-manufacturing plant, to replace its works destroyed several months ago with loss estimated at about $150,000. The new plant with equipment will cost close to a like amount.

HOBOKEN—The White Metal Mfg. Co., 1006 Clinton St., has commenced excavations for the erection of a 2-story addition to its plant on the Paterson Plank Road, North Bergen, to cost about $50,000. Leo Feinen, 3697 Boulevard, Jersey City, N. J., is architect.

WAYNE — Fire April 19 destroyed the Corning Mill at the local powder plant of E. I. du Pont de Nemours & Co., Wilmington, Del. It was caused by an explosion. The estimated loss has not been announced.

New York

LOCKPORT—The A. W. Jack Corp., North Transit Road, manufacturer of asbestos mill board and other asbestos specialties, is completing plans for the erection of the first unit of its proposed new plant, to be 1-story, 125 x 500 ft., and estimated to cost in excess of $300,000. George F. Hardy, 309 Broadway, New York, N. Y., engineer, will call for bids at an early date.

BUFFALO—The Webb Clean Sweep Co., manufacturer of floor-sweeping compounds and other chemical products, is planning for the erection of a new 1-story plant on Troupe St., near Westcott St. I. H. Webb heads the company.

ONEIDA—The Maxwell Steel Vault Co., 4 Warner St., has awarded a contract to Frazio & Millard, Oneida, for the erection of the first unit of its new plant, to be 1-story, 60 x 90 ft., and estimated to cost about $30,000, including equipment. Work will be commenced at once.

RENSSELAER—The Grasselli Chemical Co., 347 Madison Ave., New York, has plans under way for the erection of a 1-story building on local site.

Oklahoma

BARTLESVILLE—The Bartlesville Zinc Co. will make a number of improvements in its plant, including repairs to equipment. The works have been closed for the betterment program.

Pennsylvania

LOCK HAVEN—The Queens Run Refractories Co., is considering the erection of a new 1-story addition. Improvements will be made in the present plant. William Sleicher is president.

PHILADELPHIA—The United Gas Improvement Co., Broad and Arch Sts., has tentative plans under way for the construction of a new artificial gas plant, to cost in excess of $1,500,000. The exact location has not been announced.

PHILADELPHIA—The Shingle Leather Co., 315 Vine St., has completed plans for the erection of a new plant at Grays Ave. and 54th St. Work will be commenced at an early date.

ALLENTOWN — The plant of Robert A. Reichard, devoted to the manufacture of fertilizers, has been acquired at a public sale by Harry H. Shisler and associates for a consideration of $30,500. The plant represents an investment of $150,000. The new owners will organize a company and operate the works for the same line of manufacture as heretofore, including phosphates, etc. A number of improvements will be made.

Texas

ROBSTOWN—The Nueces County Water Improvement Commissioners, District No. 3, are planning for the installation of a new purification plant in connection with extensions and improvements in the local waterworks.

WEATHERFORD—The Weatherford Refining Co., operating a local oil refinery, has been reorganized. Plans are under way for the erection of an addition to the plant, with extensive improvements in the present refinery. New equipment will be installed. The company has increased its capitalization to $200,000.

MOUNT PLEASANT—The City Council will install a new filtration plant in connection with extensions in the local waterworks. H. S. Wilder is engineer.

BRECKENRIDGE—The Ebony Carbon Co. has made application to the State Railroad Commission for permission to build a local plant for the manufacture of hydro-gas carbon. The initial works will have a capacity of about 3,000 lb. of carbon black every 24 hours, consuming approximately 2,000,000 ft. of gas in this period.

Washington

CENTRALIA—The Vader Tile Co., organized to take over and operate the plant of the Standard Clay Co., has plans under way for the reconstruction of a large portion of the works, with enlargements in a number of departments. Additional equipment will be installed.

SEATTLE—The Pacific Oil Mills will soon commence the construction of an addition to the tankage department at its vegetable oil mills on East Marginal Way.

Canada

MONTREAL, QUE.—The Hochelaga Cement Co., Ltd., recently organized with a capital of $3,000,000, will operate a large local cement mill. The initial plant will have a capacity of about 2,000 bbl. a day, and this will be increased to 5,000 bbl. output at a later date.

New Companies

THE EASTERN CHEMICAL CO., Trenton, N. J., has been incorporated with a capital of $100,000, to manufacture chemicals and chemical byproducts. The incorporators are Harry and M. H. Bernstein, and Solomon R. Block, 137 East State St., Trenton.

THE MCMULLEN PETROLEUM & REFINING Co., 220 South State St., Chicago, Ill., has been incorporated with a capital of $75,000, to manufacture refined oil products. The incorporators are Frank R. Cain, Charles A. Snapp and Stillman T. Meservey.

THE PUGET SOUND REDUCTION Co., Buffalo, N. Y., has been incorporated with a capital of $150,000, to manufacture fertilizer products. The incorporators are E. Stengel, P. J. Ferkel and J. Gehm. The company is represented by Sullivan, Bagley & Wechter, Chamber of Commerce Bldg., Buffalo.

THE BARRON-NORCROSS SOAP CORP., Hamilton, Mass., has been incorporated with a capital of $10,000, to manufacture soaps and affiliated products. Harry Barron is president, and Austin L. Norcross, South Hamilton, Mass., treasurer.

THE WHEELING OXYGEN Co., Wheeling, W. Va., has been incorporated with a capital of $200,000, to manufacture commercial oxygen and kindred products. The incorporators are W. H. Frank, P. J. McGinley and James W. Ewing, all of Wheeling.

THE UNIFORM OIL Co., 1231 Calvert Bldg., Baltimore, Md., has been incorporated with a capital of $25,000 and 2,500 shares of stock, no par value, to manufacture oil products. The incorporators are W. Howard Hamilton, W. Woodward Cook and William S. Hammond.

THE SHEA CHEMICAL Co., 1107 White Bldg., Seattle, Wash., has been incorporated with a capital of $50,000, to manufacture chemicals and chemical byproducts. The incorporators are George A. Shea and F. W. Strang.

THE BERKSHIRE OIL Co., Pittsfield, Mass., has been incorporated with a capital of $25,000, to manufacture oil products. The incorporators are William S. and Irwin H. Farrar, and Adam D. Hall, all of Pittsfield.

THE COZZINS CHEMICAL Co., Madison, N. J., has been incorporated with a capital of $50,000, to manufature chemicals and chemical byproducts. The incorporators are Fred A. Brown, William Scott and William J. Nicholson, all of Madison.

THE PITTSBURGH SLAG BRICK & TILE Co., Pittsburgh, Pa., has been incorporated under Delaware laws with capital of $100,000, to manufacture brick, tile and kindred products. The incorporators are Robert L. Taylor, William C. Taylor and C. Q. Markhart, all of Pittsburgh. The company is represented by the Colonial Charter Co., Ford Bldg., Wilmington, Del.

THE COLUMBIA ENAMEL Co., Albany, N. Y., has been incorporated with a capital of $50,000, to manufacture enamels and kindred products. The incorporators are J. J. Schulda, R. Phillips and A. P. Sponable. The company is represented by C. R. Watson, Albany.

THE FLO-TEX OIL Co., Tampa, Fla., has been incorporated with a capital of $150,000, to manufacture petroleum products. George M. Thompson is president; R. E. Moore, vice-president; and V. B. Thompson, secretary.

THE CASALE AMMONIA Co. OF AMERICA, INC., Jersey City, N. J., has been incorporated with a capital of 100 shares of stock, no par value, to manufacture ammonia and kindred products. The incorporators are George H. Russell, George J. Nutting and Samuel Drayton. The company is represented by the New Jersey Coroporation Agency, 243 Washington St., Jersey City.

THE ALCO CHEMICAL CORP., Brooklyn, N. Y., has been incorporated with a capital of $12,000, to manufacture chemicals and chemical byproducts. The incorporators are A. H. Green, H. M. Gordon and I. A. A. Blish. The company is represented by Samson Selig, 233 Broadway, New York.

THE DENMAN CORD TIRE Co., Edgemere, N. Y., has been incorporated with a capital of $100,000 under Delaware laws, to manufacture automobile tires and other rubber products. The incorporators are R. H. Johnson, Edgemere; A. H. Shapiro, New York; John A. Morris, Westchester, N. Y.; and Frank Fritts, South Beach, Conn. The company is represented by the Registrar & Transfer Co., 900 Market St., Wilmington, Del.

THE WOLVERINE OIL CORP., 711 West University Ave., Champaign, Ill., has been incorporated with a capital of $250,000, to manufacture oil products. The incorporators are Fred W. Green, Howard C. Lawrence and John W. Stipes.

THE WINEGAR PRODUCTS Co., Syracuse, N. Y., has been incorporated with a capital of $10,000, to manufacture boiler compounds and kindred specialties. The incorporators are C. E. Brown, J. S. Armstrong and R. S. Davis. The company is represented by R. T. Murray, attorney, Syracuse.

THE DIAMOND TWIN CORP., Hoboken, N. J., has been incorporated with a capital of $20,000, to manufacture chemicals and chemical byproducts. The incorporators are Ralph M. Ketcham, William A. Sands, Jr., and Edwin S. White, Clinton St., Hoboken.

THE VELVO-LITE PRODUCTS Co., 3826-28 Indiana Ave., Chicago, Ill., has been incorporated with a capital of $50,000, to manufacture paste specialties, etc. The incorporators are Harrington A. Talbot, J. W. Montgomery and T. L. Douglas.

THE JEWELL OIL Co. OF KENTUCKY, Lexington, Ky., has been incorporated with a capital of $100,000, to manufacture petroleum products. The incorporators are John B. and M. H. W. Jewell, and Harry M. Rowe, all of Lexington.

THE WINCHESTER BRICK Co., Winchester, Mass., has been incorporated with a capital of $50,000, to manufacture brick, tile and other burned clay products. John K. Whiting, Longwood Ave., Brookline, Mass., is president and treasurer; Isaac S. Whiting, is vice-president.

THE INTERNATIONAL PRODUCING & REFINING Co., Wilmington, Del., has been incorporated with a capital of $500,000 under state laws, to manufacture refined petroleum products. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington.

THE CONSTANT HEAT CORP., Albany, N. Y., has been incorporated with a capital of $200,000, to manufacture chemical heat packing, and other chemical products. The incorporators are O. L. and L. L. Perrault, and C. Z. Smith. The company is represented by E. A. Gifford, Albany.

TH ST. CLAIR SILICA Co., 744 North Third St., East St. Louis, Ill., has been incorporated with a capital of $30,000, to manufacture refined silica and silica products. The incorporators are W. D. Abraham, A. J. Kahle and William A. Luft.

THE SCUORZO CHEMICAL LABORATORIES Co., Newark, N. J., has filed notice of organization to manufacture chemicals and chemical byproducts. Ernest and Alfred A. Scuorzo, 235 Oliver St., Newark, head the company.

THE ES-TE OIL Co., Chicago, Ill., has been incorporated under Delaware laws with a capital of $2,000,000, to manufacture refined oil products. The incorporators are H. L. Casey, C. W. Smith and T. Goodrich, all of Chicago. The company is represented by the Colonial Charter Co., Ford Bldg., Wilmington, Del.

THE WELLSBURG PAPER Co., Wellsburg, W. Va., has been incorporated with a capital of $500,000, to manufacture pulp and paper products. The incorporators are George T. H. Hammond, Thomas George and Allen Burt, all of Wellsburg.

THE SOAP SALT Co., Tarentum, Pa., has been incorporated under Delaware laws with capital of $100,000, to manufacture washing compounds and kindred products. The incorporators are J. F. Henry, Tarentum; J. B. and L. H. Cowan, both of Brackenridge, Pa. The company is represented by the Capital Trust Co. of Delaware, Dover, Del.

THE HAT CITY FOUNDRY Co., Danbury, Conn., has been incorporated with a capital of $15,000, to manufacture iron, steel and other metal castings. The incorporators are F. A. Shepard, E. S. Roos and J. P. Fahy, all of Danbury.

POUCHER, TRABOLD & SIDNEY, INC., New York, N. Y., has been incorporated with a capital of $225,000, to manufacture leather products. The incorporators are R. I. Poucher, P. Sidney and F. W. Trabold. The company is represented by Churchill, Marlow & Hines, 63 Wall St., New York.

THE LEONARD CHEMICAL Co., 10 South La Salle St., Chicago, Ill., has been incorporated with a capital of $25,000, to manufacture chemicals and chemical byproducts. The incorporators are John A. Kelly, T. J. and A. M. Leonard.

THE CALVERT OIL Co., Fort Smith, Ark., has been incorporated with a capital of $25,000, to manufacture petroleum products. C. C. Calvert is president; C. A. Lick, vice-president; and W. E. Decker, secretary, all of Fort Smith.

THE BURTON HEIGHTS CO-OPERATIVE OIL Co., Wilmington, Del., has been incorporated under state laws with capital of $165,000, to manufacture oil products for motor and other service. The company is represented by the United States Corporation Co., 65 Cedar St., New York.

THE MAWSON INK Co., Boston, Mass., has filed notice of organization to manufacture ink and kindred products. William F. Simpson, 334 Cambridge St., Allston, Mass., heads the company.

THE HART-PEDERSON GLASS Co., 3242 Carroll Ave., Chicago, Ill., has been incorporated with a capital of $10,000, to manufacture glass products. The incorporators are Walter V. Hart and Paul N. Pederson.

THE LIQUID SOAP Co., 128 North Wells St., Chicago, Ill., has been organized to manufacture soaps and other products. The company is headed by I. C. Brennan and T. Deutsch.

Capital Increases, Etc.

THE RUDOLPH PAPER Co., INC., 2740 Park Ave., New York, N. Y., has filed notice of increase in capital from $100,000 to $500,000.

THE Z. & M. INDEPENDENT OIL Co., Norwich, N. Y., has filed notice of increase in capital from $50,000 to $100,000.

THE SERVICE RUBBER Co., Chicago, Ill., manufacturer of rubber products, has filed notice of increase in capital from $500,000 to $1,000,000.

THE HOLSTON TILE Co., Rogersville, Tenn., has filed notice of increase in capital from $35,000 to $100,000.

THE CHEROKEE CHEMICAL Co., Gaffney, S. C., has filed notice of increase in capital from $50,000 to $200,000. George Riehl is secretary.

THE HERCULES WATERPROOF CEMENT Co., Mutual Life Bldg., Buffalo, N. Y., has arranged for reduction in capital from $150,000 to $50,000.

THE AMERICAN VULCANIZED FIBRE Co., Wilmington, Del., has filed notice of change of name to the Fibre Securities Co.

THE BRIDGEPORT BRASS FOUNDRY, INC., Bridgeport, Conn., has filed notice of dissolution under state laws.

THE MANATI SUGAR Co., 112 Wall St., New York, N. Y., has disposed of a bond issue of $8,000,000, the proceeds to be used for general operations, financing, etc.

THE NEW ENGLAND OIL REFINING Co., 19 Milk St., Boston, Mass., has arranged for the sale of bonds for $1,000,000, to be used for general operations.

Industrial Notes

KURT MUNZINGER of Buffalo, N. Y., sailed recently from New York for Havre, France. From Havre Mr. Munzinger will go to Barcelona, Spain, to open a foreign office for Pratt & Lambert, Inc., Buffalo, manufacturer of varnish. He will also care for the company's interests in Spain, Holland, Denmark, Sweden, Norway and Finland.

THE PFAUDLER Co. has moved its New York office from 110 West 40th St. to 8 West 40th St.

THE COMBUSTION ENGINEERING CORP., New York, announces that it has recently completed arrangements with the Power Plant Equipment Co. of Kansas City, Mo., to represent it in that territory.

THE SOUTHWESTERN ENGINEERING Co., Los Angeles, Cal., has recently appointed D. W. Salsbury Eastern manager, with offices at 200 Broadway, New York City. Mr. Salsbury will act as Eastern manager for the Southwestern Condenser Co. and will have charge of all Eastern sales for the MacCamy condenser and intercooler.

THE DRIVER-HARRIS Co., Harrison, N. J., announces that on May 1 its Chicago branch moved to larger quarters at 562-574 West Randolph St.

THE IRON PRODUCTS CORP., the Central Foundry Co., the Central Iron and Coal Co., the Chattanooga Iron and Coal Corp., the Molby Boiler Co. and the Central Radiator Co., have moved their New York offices to 41 East 42nd St.

W. H. CAMPBELL, for the past 2 years general sales manager of the Charleston Industrial Corp. at Nitro, W. Va., announces the opening of offices as W. H. Campbell, Inc., at 30 Church St., New York City. This business has been incorporated for the sale of new and carefully inspected used chemical, refrigeration and power apparatus. While with the Charleston Industrial Corp. Mr. Campbell devoted his time to the sale of equipment for the former government munitions plant at Nitro, purchased by the company.

New Publications

INDUSTRIAL STABILITY is the title of a book, Vol. V, No. 1, dated January, 1922, published by the Society of Industrial Engineers, which is a complete report of the proceedings of the seventh national convention held under the auspices of the Society of Industrial Engineers at Springfield, Mass., Oct. 5, 6 and 7, 1921.

THE DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH (London) has published Special Report No. 1, by the Fuel Research Board, on "Pulverized Coal Systems in America," by Leonard C. Harvey.

THE IMPERIAL INSTITUTE (London) has published a new edition, revised and enlarged, on "Potash," by Sydney J. Johnstone, which has been prepared under the direction of the Mineral Resources Committee of the Imperial Institute with the assistance of the scientific and technical staff. Copies can be obtained from John Murray, Albemarle Street, W., London, at 6s. net.

THE IMPERIAL MINERAL RESOURCES BUREAU has published "Laws and Regulations Relating to Lead Poisoning," being an analysis with texts of the laws and regulations made in the chief industrial countries to prevent Plumbism, by Gilbert Stone. Copies can be obtained from H. M. Stationery Office, London, England, at 5s. net.

Manufacturers' Catalogs

WILSON-MAEULEN CO., New York, has issued its fourteenth Pyrometer Catalog. It illustrates and describes the Tapalog, both single- and multi-record pyrometer recorders, high-resistance Monopivot indicator, Monopivot pyrometers, pyods and accessories.

THE SOUTHWESTERN CONDENSER CO., 1228 Hollinsworth Bldg., Los Angeles, Cal., has issued Bull. A-5, on "Intercoolers and Aftercoolers for Compressors."

THE ELECTRO METALLURGICAL SALES CORP., New York, has just received from the press its new catalog entitled "Electromet Brand Ferro-Alloys and Metals." This attractive 26-page booklet gives a brief description of the most important Electromet brand products and their uses in the fields of ferrous and non-ferrous metallurgy, together with some historical statements.

W. S. ROCKWELL CO., New York, in Bull. 241, on "Forging and Heating Furnaces," has prepared a booklet on the need for better heating in forging and forming practice. It indicates some fundamental principles affecting the quality and cost of forgings and other formed parts that are generally overlooked in practice. It is claimed that proper application of the ideas outlined should lead to better and cheaper products, irrespective of the form of furnace or fuel employed. Illustrations of typical equipment are shown, with descriptions of the heating and handling methods employed to meet a wide variety of plant and manufacturing conditions, form and cost of available fuels.

STRUTHERS-WELLS CO., Warren, Pa., manufacturer of steel plate equipment for the chemical, petroleum refining, iron and steel, creosoting, paper, soap, alcohol and related industries, has published a new and well-illustrated catalog. Descriptions of plate shop, engineering department, welding shop, foundry, machine shop are complete and well illustrated. Among the products are tanks, kettles, coolers, agitators, stills, flues, boilers, etc.

Industrial Developments

CERAMIC—The Blackwell Brick Mfg. Co., Blackwell, Okla., has resumed operations on a capacity basis, following a shut-down for some time past. More than 60 men will be employed, with output totaling 40,000 bricks a day.

All brick-manufacturing plants in the Birmingham, Ala., district are operating on a full-time, full-capacity basis.

Potteries at East Liverpool, O., and vicinity have increased capacities to 90 and 95 per cent of normal. A number of chinaware plants are operating under full production. During March a total of 13,000 packages of chinaware was shipped from the Sebring, O., territory, establishing a new high record.

RUBBER—The Vulcanized Rubber Co., Morrisville, Pa., manufacturer of hard rubber products, has increased operations to a capacity basis. Orders on hand insure this basis of output for more than 12 months to come in a number of departments. Employment is being given to 400 persons.

The Lehigh Tire & Rubber Co., New Castle, Pa., is increasing production and adding to its working force. Close to normal operations are being maintained.

The Firestone Tire & Rubber Co., Akron, O., has advanced production to a basis of 22,000 tires a day, as against 20,000 tires during the early weeks of April.

The Goodyear Tire & Rubber Co., Akron, O., has increased manufacture from 22,000 to 24,000 tires a day. About 1,000 additional employees have been added to the working force during April.

GLASS—The Sneath Glass Co., Hartford City, Ind., has resumed operations in its blowing department, following a curtailment for a number of weeks. Improvements have been made for increased production.

The majority of the large glass bottle-manufacturing plants at Millville, N. J., have adopted a full time operating schedule. Tube workers in this section have accepted a wage reduction of 15 per cent.

LEATHER—The B. D. Eisendrath Tanning Co., Racine, Wis., is increasing production in its calf leather department, and is arranging for further enlargement at an early date.

The American Hide & Leather Co. is increasing production at its tanneries in the Chicago, Ill., district for calf and grain material. The upper leather plants of the company in different parts of the country are running at 50 to 100 per cent capacity, with present average in excess of 75 per cent.

The Continental Leather Co., Philadelphia, Pa., is advancing the production schedule in the hide departments at its two tanneries in Virginia. Plans are under way for the establishment of a new leather plant in the vicinity of Elkton, Va.

IRON AND STEEL—The Republic Iron & Steel Co., Youngstown, O., has resumed operations at its bessemer plant, idle for more than a year past. The company now has thirteen sheet mills in service in this district, and has also resumed at its plate mill.

The Crucible Steel Co., Pittsburgh, Pa., has blown in another blast furnace at its mills.

The McKinney Steel Co., Cleveland, O., is arranging for the immediate resumption of operations at its open-hearth plant. Four furnaces will be lighted.

The Bethlehem Steel Co. is increasing production at its Steelton, Pa., works. Blast furnace "B" at this plant, which has been out of commission for about a year past, will be blown in within the next fortnight, for pig-iron production. Operations are being advanced in the coke-oven department, and men added to the working force.

The Woodward Iron Co., Birmingham, Ala., has made its No. 2 Vanderbilt furnace ready for operation, and the unit will be blown in at once.

The Tennessee Coal, Iron & Railroad Co. is making ready to place another bessemer furnace in operation at its Ensley, Ala., works.

The LeMoyne Steel Co. has resumed operations at its plant at New Eagle, near Washington, Pa., following a shut-down for several months.

The Eastern Rolling Mill Co., Baltimore, Md., manufacturer of steel sheets, is arranging for an immediate advance in production from 90 to 100 per cent capacity, the first that the mill has been on this basis for some time past. Additions are being made to the working force.

The Newport Rolling Mill Co., Newport, Ky., will place additional sheet and tin mills in service during the next fortnight. A total of eleven mills are now in operation at the works. The working force is being increased.

MISCELLANEOUS—The Atlas Powder Co. has resumed production on a full-time basis at its plant at Tamaqua, Pa.

The Vulcanite Cement Co., Vulcanite, N. J., is maintaining full operations at its local plant, and has advanced the wages of employees 6 cents an hour. The Edison Portland Cement Co., New Village, N. J., in this same district, is running full, and has announced a wage increase for operatives of 5 cents an hour.

The American Trona Corp. has reopened its potash plant at Searles Lake, Cal., following a shut-down for nearly a year past.

The Atlas Mineral Products Co., Mertztown, Pa., has resumed operations at its plant, following a suspension of operations for some time past.

Coming Meetings and Events

ASSOCIATION OF CHEMICAL PLANT EQUIPMENT MANUFACTURERS will meet at the Chemists' Club, 52 East 41st St., New York, on May 10, to complete organization, elect officers and oppoint committees.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold a joint meeting with the Pacific Division of the association, on the occasion of the annual meeting of the latter, in Salt Lake City June 22 to 24.

AMERICAN ASSOCIATION OF ENGINEERS will hold its eighth annual convention at Salt Lake City, Utah, June 4-6.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its next convention and exhibit at Rochester, N. Y., during the week of June 5, 1922. Meetings will be held in the spring instead of in the fall as heretofore.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its summer meeting at Niagara Falls, Canada June 19 to 22. Headquarters will be at the Clifton Hotel.

AMERICAN LEATHER CHEMISTS ASSOCIATION will hold its nineteenth annual meeting at Bigwin Inn, Bigwin Island, in the Lake of Bays district, Ontario, Canada, on June 21, 22 and 23.

AMERICAN OIL CHEMISTS' SOCIETY will hold its annual meeting at the Grunewald Hotel, New Orleans, La., May 8 and 9.

AMERICAN PULP AND PAPER MILL SUPERINTENDENTS ASSOCIATION will meet in Kalamazoo, Mich., June 1, 2 and 3.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS will hold its spring meeting at Atlanta, Ga., May 8-11.

AMERICAN SOCIETY FOR STEEL TREATING will hold a sectional meeting at the Bureau of Mines auditorium, Pittsburgh, Pa., on May 25 and 26. The International Steel Exposition and Convention of the society will be held in the General Motors Bldg., Detroit, Mich., Oct. 2 to 7.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its twenty-fifth annual meeting June 26 to July 1, at Atlantic City, N. J. Headquarters will be at the Chalfonte-Haddon Hall Hotel.

ANNUAL SAFETY CONGRESS of the NATIONAL SAFETY COUNCIL will be held in Detroit, Mich., Aug. 28-Sept. 2.

CANADIAN INSTITUTE OF CHEMISTRY and the SOCIETY OF CHEMICAL INDUSTRY will hold their annual meetings in Ottawa May 15-17.

CERAMIC SOCIETY (London) is to have a foreign trip to Sweden and Denmark from May 27 to June 10.

INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY will hold a meeting at Lyons, France, June 27 to 30.

IRON AND STEEL INSTITUTE (British) will hold its annual meeting on May 4 and 5 at the House of the Institution of Civil Engineers, Great George St., S. W., 1, London.

NATIONAL ASSOCIATION OF PURCHASING AGENTS EXPOSITION (the "Informashow") will be held in connection with the seventh annual convention of the association at Exposition Park, Rochester, N. Y., May 15-22.

NATIONAL COAL ASSOCIATION will hold its annual meeting at Congress Hall, Chicago, May 24-25.

NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (EIGHTH) will be held in New York Sept. 11-16.

NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING will be held at the Grand Central Palace Dec. 7-13, with the exception of the intervening Sunday.

NATIONAL FERTILIZER ASSOCIATION will hold its twenty-ninth annual convention at the Greenbrier, White Sulphur Springs, W. Va., the week of June 12.

NEW JERSEY CHEMICAL SOCIETY will meet at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

TANNERS' COUNCIL will meet at the Copley-Plaza Hotel, Boston, May 4 and 5.

The following meetings are scheduled to be held in Rumford Hall, the Chemists Club, New York: May 5—American Chemical Society, regular meeting; May 12—Société de Chimie Industrielle (in charge), American Chemical Society, Society of Chemical Industry, American Electrochemical Society, joint meeting; May 19—Society of Chemical Industry, regular meeting; June 9—American Chemical Society, regular meeting.